



# Book of Abstract

7TH EUROPEAN CONFERENCE  
ON SCIENTIFIC DIVING  
ROSCOFF-FRANCE  
14 – 18 MAY 2023







**European Conference**  
on **Scientific Diving**

# 7<sup>th</sup> European Conference on Scientific Diving

Roscoff - France  
14 - 18 May 2023





<b>MAY 14, 2023</b>			<b>Arrival of the participants</b>
16:30-18:30			Welcome of the participants, check-in
18:30-19:30			<b>Icebreaking</b>
19:30			<b>Free Dinner</b>

MAY 15, 2023	SPEAKER	INSTITUTION	TITLE
8:30 - 9:15			Welcome of the participants, check-in
9:15 - 9:30	Gérard Thouzeau / Romain Crec'hriou	National Committee of Scientific Diving (CNPS) / Roscoff Biological Station	Opening remarks
			<b>SESSION 1 - Marine habitats: ecological state, conservation and restoration issues linked to global changes</b> <b>Chairperson: Maria Salomidi (HCMR)</b>
9:30 - 10:15	<b>Simonetta Fraschetti</b>	<b>University of Naples Federico II, Biology Department, Naples (Italy)</b>	<b>Guest lecture 1 - Key challenges in marine conservation and restoration: a Mediterranean perspective</b>
10:15 - 10:30	Ingrida Andersone	Latvian Institute of Aquatic Ecology (Latvia)	Investigation of stony reef habitats in the Latvian EEZ for designation of new MPAs
10:30 - 11:00			<b>Coffee break</b>
11:00 - 11:15	Lucy May	Natural England (United Kingdom)	LIFE Recreation ReMEDIES: Subtidal seagrass surveys
11:15 - 11:30	Paulo Torres	CIBIO-InBIO, Univ. of the Azores (Portugal)	Multivariate analysis on the effects of marine reserves in species diversity, distribution and abundance based on underwater visual census
11:30 - 11:45	Martina Coppari	Università Politecnica delle Marche (Italy)	Standardized underwater methodologies to monitor climate change effects: the Interreg MED MPA Engage project
11:45 - 12:00	Thanos Dailianis	Hellenic Centre for Marine Research, Institute of Mar. Biol., Biotechnol. & Aquaculture (Greece)	Experimental cultivation of sponges within fish farms - Assessment of growth and survival
12:00 - 12:15	Maria Salomidi	Hellenic Centre for Marine Research, Institute of Oceanography, Anavyssos, Attika (Greece), Univ. of Trieste (Italy)	Reforesting Gyaros MPA reefs (N. Cyclades, Greece) within the LIFE REEForest initiative
12:15 - 12:30	Elisabeth Riera	Muséum National d'Histoire Naturelle, UMR 8067 - BOREA, Paris (France)	Artificial reefs efficiency changes among types and following coastal development, as revealed by underwater hyperspectral imagery
13:00 - 14:00			<b>Lunch</b>
			<b>SESSION 2: Marine fish biodiversity and ecology</b> <b>Chairperson: Philippe Lenfant (UPVD)</b>
14:00 - 14:45	<b>Pierre Thiriet</b>	<b>PatriNat, Dinard Marine Biological Station (MNHN), Dinard (France)</b>	<b>Guest lecture 2 - Scientific diving: an essential tool to study fish ecology in subtidal reefs</b>
14:45 - 15:00	Yiannis Issaris	Hellenic Centre for Marine Research, Institute of Oceanography, Anavyssos, Attika (Greece)	Stereo-video transect surveys for the assessment of coastal rocky fish assemblages in the Gyaros MPA in Greece
15:00 - 15:15	Justine Richaume	Septentrion Environnement (France)	Stereo-photogrammetry tools for efficient underwater 3D data acquisition
15:15 - 15:30	Tiffany Monfort	Institut méditerranéen d'Océanologie, Aix-Marseille Univ., Septentrion Environnement (France)	Use of photogrammetry-based descriptors to assess the effect of 3D structure of shallow Mediterranean rocky reefs on teleost assemblages
15:30 - 15:45	Andrea Spinelli	Research Department, Fundacion Oceanografic de la Comunitat Valenciana, Valencia (Spain)	Assessment of biodiversity and checklist of demersal fish species in a ghost net affected area, Tyrrhenian Sea, Sicily, Italy
15:45 - 16:00	Philipp Fischer	Alfred Wegener Institute for Polar and Marine Research (Germany)	The cold side of climate change. Diver supported shallow water observatory operation in the Arctic
16:00 - 16:30			<b>Coffee break</b>
16:30 - 18:00			<b>Poster session</b>
19:30			<b>Dinner</b>

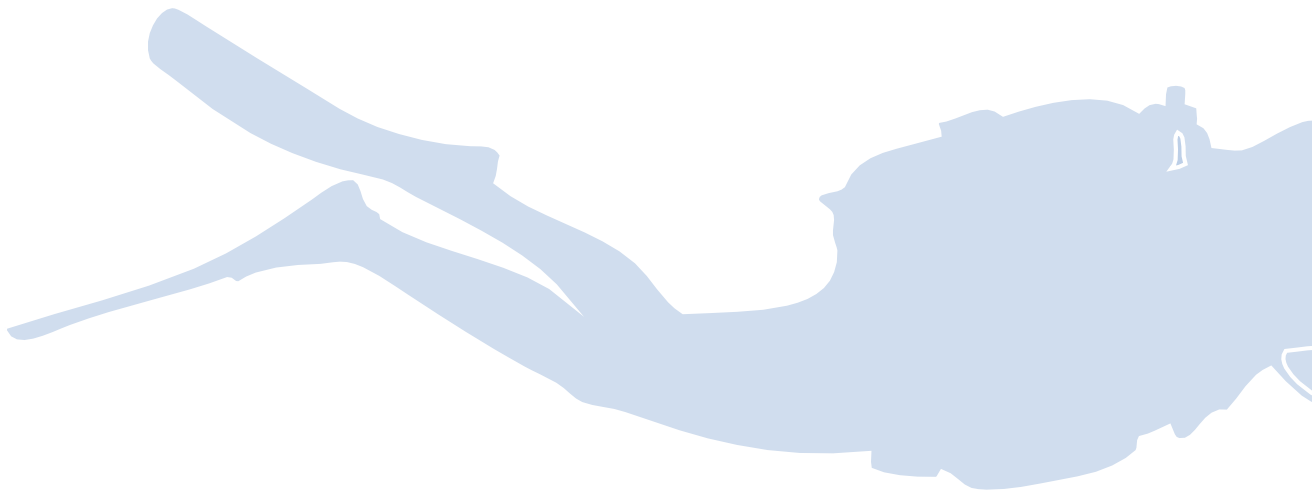
MAY 16, 2023	SPEAKER	INSTITUTION	TITLE
			<b>SESSION 3 - Underwater archaeology and marine services provided by shipwrecks</b> <b>Chairperson: Nicolas Bigourdan (DRASSM)</b>
8:30 - 9:15	Nicolas Bigourdan	DRASSM, Marseille (France)	<b>Guest lecture 3 - Underwater Archaeology in France: history and perspectives</b>
9:15 - 9:30	Minna Koivikko	The Finnish Heritage Agency (Finland)	Diverse diving discoveries - from an 18th century cannon to nodules of white phosphorus
9:30 - 9:45	Kinga Korniejenko	Cracow University of Technology (Poland)	The usage of virtual and augmented reality in underwater archeology
9:45 - 10:00	Kimon Papadimitriou	Aristotle Univ. of Thessaloniki, Faculty of Engineering (Greece)	Modern Wrecks in the Greek Seas. Documentation, Promotion, Challenges
10:00 - 10:15	Peter Almond	School of Natural and Environmental Sciences, Newcastle Univ. (UK)	Using three-dimensional photogrammetry to investigate effects of structure on shipwreck-associated communities
10:15 - 10:30	Rachael Priest	School of Natural and Environmental Sciences, Newcastle Univ. (UK)	Shipwrecks: The Overlooked Ecosystems
10:30 - 10:55			<b>Coffee break</b>
			<b>SESSION 4 - Occupational versus recreational scientific diving: the emergence of citizen sciences in long-term and large-scale monitoring - Chairperson: Alain Norro (RBINS)</b>
10:55 - 11:15	Jean-Pierre Féral	IMBE, Aix Marseille University (France)	European standards for initial training in scientific diving, a necessity and a guarantee for the mobility of scientists and effective research in the coastal environment
11:15 - 11:30	Valentin Danet	MNHN, Station Marine de Dinard, CRESCO, Dinard (France)	Nature based mooring systems, to involve recreational divers in citizen science programs and increase awareness on conservation of temperate reef ecosystems
11:30 - 11:45	Lucie Vanalderweireldt	UMR LEFE, CNRS, ENSAT, Castanet-Tolosan (France)	A Mediterranean 'VIT-Reef' diving protocol for monitoring a Sea under siege
11:45 - 12:00	Eva Turicchia	University of Bologna - Reef Check Italia Onlus (Italy)	What's going on at the core of the Coral Triangle? Results from 10 years of Reef Check and Coral Watch monitoring
12:00 - 12:15	Abigail Moore	Hasanuddin Univ. - Association of Diving Schools (Indonesia)	Tridacnid clam status in Indonesia from two decades of Reef Check survey data (1997-2017)
12:15 - 12:30	Philippe Lenfant	UPVD, CEFREM, Perpignan (France)	Participatory science in diving at the service of the assessment of the reserve effect (POCTEFA RESMED project)
13:00 - 14:00			<b>Lunch</b>
			<b>SESSION 5 - Underwater scientific diving tools and techniques: focus on the mesophotic and circalittoral zones</b> <b>Chairperson: Martin Sayer (Tritonia Scientific)</b>
14:00 - 14:45	Laurent Ballesta	Andromède Océanologie, Maugio-Carnon (France)	<b>Guest lecture 4 - CCR and saturation dives during the Gombessa experiments: new options to access the mesophotic zone</b>
14:45 - 15:00	Alain Norro	Royal Belgian Institute of Natural Sciences, Bruxelles (Belgium)	European best practice for using Closed-Circuit Rebreather for Scientific diving at work. The ESDP consultation document
15:00 - 15:15	Régis Hocdé	Univ. of Montpellier, UMR MARBEC, Montpellier (France)	Challenging issues for the study of the mesophotic ecosystems by environmental DNA metabarcoding
15:15 - 15:30	Quentin Schull	Univ. of Montpellier, UMR MARBEC, Montpellier (France)	Monitoring the plasticity and resilience of gorgonians in the Mediterranean sea. A case study in the Calanques National Park (Marseille)
15:30 - 15:45	Georg Martin	Estonian Marine Institute (Estonia)	Methodology for estimating environmental impact of Offshore Windparks on benthic ecosystems - EIA study from NE Baltic Sea
15:45 - 16:00	Daniele Ventura	Dpt of Environmental Biology, Sapienza Univ. of Rome ( Italy)	Integrating Diver Propulsion Vehicles (DPVs) with Structure from Motion photogrammetry: a low-cost tool for effective reconstruction of the underwater environments
16:00 - 16:30			<b>Coffee break</b>
16:30 - 18:00			<b>Poster session</b>
19:00			<b>Aperitif</b>
19:30			<b>Gala dinner</b>

MAY 17, 2023	SPEAKER	INSTITUTION	TITLE
			<b>SESSION 6 - Underwater scientific diving tools and techniques: focus on freshwater and estuarine areas</b> <b>Chairperson: Mario Lepage (INRAE)</b>
8:30 - 9:15	Claire Paris-Limouzy	Univ. of Miami, Rosenstiel School of Marine and Atmospheric Science, Miami (USA)	Guest lecture 5 - Scientific Freediving: a safe and effective solution for challenging locations and type of data to be acquired
9:15 - 9:30	G�rard Thouzeau	CNRS, UMR 6539 - LEMAR, Univ. Brest, IUEM, Plouzan� (France)	Estimating benthic biogeochemical fluxes in mangrove ecosystems: a challenge when using apnea in the Sinnamary estuary, French Guiana
9:30 - 9:45	Mateusz Draga	Department of Hydrobiology, A. Mickiewicz Univ., Poznan (Poland)	Management of invasive aquatic plants: effectiveness and environmental impact of different methods of mechanical control
9:45 - 10:00	Jacquet St�phan	INRAE, UMR CARRETEL, Thonon-Les-Bains (France)	Towards a better understanding of the ecology of <i>Hemimysis anomala</i> , an invasive alien small pelagic crustacean, in Lake Geneva
10:00 - 10:15	Anna Zrobek-Sokolnik	University of Warmia and Mazury, Olsztyn (Poland)	Application of survey methods to investigate the relationship between factors influencing the sight-aesthetic attractiveness of underwater lake landscapes
10:15 - 10:30	Massimo Ponti	University of Bologna - Reef Check Italia Onlus (Italy)	Impact of gold mining activities on the ascidian <i>Polycarpa aurata</i> in the North Sulawesi, Indonesia
10:30 - 11:00			<b>Coffee break</b>
			<b>SESSION 7 - Underwater scientific diving tools and techniques: focus on photogrammetry</b> <b>Chairperson:</b>
11:00 - 11:15	Sebastian Pose	TU Bergakademie Freiberg, Scientific Diving Center (Germany)	Underwater photogrammetry combined with different environmental data
11:15 - 11:30	Louis Hadjioannou	Cyprus Marine and Maritime Institute (Cyprus)	Using novel methodologies to monitor shallow water coral communities and investigate structural complexity
11:30 - 11:45	Bernab� Moreno	Marine Ecology Dpt, Institute of Oceanology, Polish Academy of Sciences (Poland)	Underwater procedures for long-term photographic monitoring of benthic biocoenosis in shallow hard bottoms - a perspective from the high-Arctic
11:45 - 12:00	Torcuato Pulido Mantas	Universita Politecnica delle Marche, Ancona (Italy)	Unveiling hidden seascapes: SfM-photogrammetry, a powerful tool for marine caves monitoring
12:00 - 12:15	Quentin Ternon	MNHN, Station Marine de Dinard, CRESCO, Dinard (France)	Local habitat characteristic structuring benthic community in circalittoral temperate rocky reefs, a photogrammetric based approach
12:15 - 12:30	Lisa Faresi	ARPA Regional Agency for Environmental Protection FVG (Italy)	Underwater investigation on macro-zoobenthic richness of a dam system in the harbour of Trieste (northern Adriatic Sea): a 6 year study
13:00 - 14:00			<b>Lunch</b>
14:00 - 15:30	<b>Martin Sayer</b> (convener Workshop 1) <b>Pierre Thiriet</b> (convener Workshop 2)	Tritonia Scientific Ltd., Dunstaffnage Marine Laboratories, Dunbeg, Oban (Scotland) PatriNat (OFB, MNHN, CNRS, IRD), Dinard Marine Biological Station, Dinard (France)	<b>Workshops 1 and 2, part 1</b> WS 1: <u>Technological Workshop</u> - Breakthrough Technologies Advancing Diving-Based Research WS 2: <u>Methodological Workshop</u> - How to survey fish assemblages in subtidal rocky reefs and other shallow structurally complex habitats? Discussing methodological standards to trigger European research and monitoring networks
15:30 - 16:00			<b>Coffee break</b>
16:00 - 17:30	<b>Martin Sayer</b> (convener WS 1) <b>Pierre Thiriet</b> (convener WS 2)	Tritonia Scientific Ltd., Dunstaffnage Marine Lab., Dunbeg, Oban (Scotland) PatriNat (OFB, MNHN, CNRS, IRD), Dinard Marine Biological Station, Dinard (France)	<b>Workshops 1 and 2, part 2</b>
19:00			<b>Free dinner</b>
20:30 -22:00	<b>Laurent Ballesta</b>	<b>Androm�de Oc�anologie, Maugio-Carnon (France)</b>	<b>Evening movie and conference: "Plan�te M�diterran�e"</b> (in duplex with the cinema in Roscoff for the general public)

<b>MAY 18, 2023</b>			<b>Side activities</b>
Morning (time of the dive to be specified according to the tide)			<b>Scuba diving</b> (Amoco Cadiz wreck)
Noon hours			<b>Free Lunch</b>
15:00 - 16:30			<b>Boat Tour in Morlaix Bay</b>







# List of Talks



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# Investigation of stony reef habitats in the Latvian EEZ for designation of new MPAs

Ingrida Andersone\*<sup>1</sup>, Anete Fedorovska<sup>1</sup>, Ieva Bārda<sup>1</sup>, Solvita Strāķe<sup>1</sup>, Ivars Putnis<sup>2</sup>, and Ilze Sabule<sup>3</sup>

<sup>1</sup>Latvian Institute of Aquatic Ecology – Latvia

<sup>2</sup>Institute of Food safety, Animal Health and Environment "BIOR" – Latvia

<sup>3</sup>Nature Conservation Agency – Latvia

## Abstract

Latvian coast of the Baltic Sea belongs to the most exposed shores of the Baltic Sea, hosting two habitats protected by Habitat Directive (Annex 1, Council Directive 92/43/EEC)-stony reefs (1170) and sandbanks (1110). Stony reefs are one of the most prominent, ecologically significant habitat types in the Eastern part of the Baltic Sea, and considered as a biodiversity hotspot for attracting invertebrates, fish, birds and plants. They are an area of hard substrate (rocks, boulders and pebbles) surrounded by patches of sand. On the Latvian coast, reefs present almost a two dimensional hard bottom substrate for the benthic communities on otherwise very exposed, straight coastline. The three dimensional structure can only be found on several tens of cm height range, representing the size of the largest boulders. It can be summed up, that stony reefs in the south-eastern Baltic exist on the verge of environmental limits, making them even more vulnerable to environmental disturbance, but their existence still more precious for the ecosystem functioning. Latvian coastal protected areas suffer from increasing eutrophication and onset of invasive fish species, plundering the coastal habitats. This alone accentuates the necessity of investigations into the areas outside of the current marine protected areas (MPAs). Currently 3 areas (aprox. 4000 km<sup>2</sup>) in the exclusive economic zone (EEZ) are targeted for research. These are elevated areas at 28-50m depth, which were thought to be of mixed substrate as indicated by existing sediment maps, however pilot studies have revealed the presence of reefs. The aim of the project is to assess the extent and ecological state of offshore reef habitats in the Latvian EEZ. The habitats will be evaluated against the criteria for designation of new MPAs and once identified, their connectivity to coastal MPAs will be assessed, to possibly provide the genetic material for restoration of coastal habitats. The offshore MPA assessment will enable conservation of areas of particular importance for biodiversity and ecosystem services provision through a well connected system of effectively managed, and ecologically representative protected areas. The study is performed in the framework of project: "Research of marine protected habitats in EEZ and determination of the necessary conservation status in Latvia" (LIFE REEF, LIFE19 NAT/LV/000973).

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\*Speaker

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# LIFE Recreation ReMEDIES: Subtidal Seagrass Surveys

Lucy May\*<sup>1</sup>

<sup>1</sup>Natural England – United Kingdom

## Abstract

LIFE Recreation ReMEDIES (Reducing and Mitigating Erosion and Disturbance Impacts affecting the Seabed, LIFE18 NAT/UK/000039) is a four-year project running from July 2019 to October 2023. Natural England are the lead partner in partnership with the Marine Conservation Society, Ocean Conservation Trust, Plymouth City Council/Tamar Estuaries Consultative Forum and the Royal Yachting Association. The project is financially supported by the EULIFE Programme. ReMEDIES aims to improve the health of marine habitats of European conservation importance in five Special Areas of Conservation (SACs) in southern England; the Fal and Helford SAC, the Solent Maritime SAC, Plymouth Sound and Estuaries SAC, Essex Estuaries SAC and the Isles of Scilly SAC. Large areas of the seabed within these marine protected areas are currently in unfavourable condition, in particular sensitive seagrass and maerl habitats. The project aims to reduce impacts on these habitats and protect them against recreational pressures, by implementing best practice management techniques such as Advanced Mooring Systems (AMS), voluntary codes, targeted training, encouraging behavioural change, and managing access. Underwater dive surveys have been conducted by the Natural England Dive Unit in the Fal and Helford SAC, the Solent Maritime SAC and Plymouth Sound and Estuaries SAC. The data will be used to inform condition assessments of subtidal seagrass, a sub-feature of the Annex 1 habitat 'Sandbanks which are slightly covered by sea water all the time.' Metrics measured by divers included *Zostera marina* shoot density (percent cover and shoot count), number of leaves per shoot, maximum shoot length, sediment classification, and semi-quantitative methods were used to record presence of wasting disease *Labyrinthula zosterae* and epiphyte cover. All dive surveys will be repeated at the end of the project to determine condition and measure success of the project. AMS are specially designed to reduce the interaction between the mooring and sensitive seabed habitats, including seagrass and maerl beds. AMS have recently been installed in seagrass beds at Cawsands, Plymouth Sound and Estuaries SAC, replacing traditional moorings. *In situ* monitoring of the seagrass beds using divers is being undertaken in collaboration with the University of Plymouth to measure the effectiveness of the AMS. Variables measured are shoot density (percent cover and shoot count), canopy height and sediment character. This poster presents the ReMEDIES survey methods and the key findings of these surveys to date.

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\*Speaker

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# Multivariate analysis on the effects of marine reserves in species diversity, distribution and abundance based on underwater visual census

Paulo Torres<sup>\*1</sup>, Danko Castano<sup>1</sup>, Ana Costa<sup>1</sup>, Manuela Parente<sup>1</sup>, and Andrea Zita<sup>1</sup>

<sup>1</sup>CIBIO, Research Centre in Biodiversity and Genetic Resources - InBIO Associate Laboratory, Azores Pole, University of the Azores, Rua Mãe de Deus, 9501-801 Ponta Delgada, Portugal – Portugal

## Abstract

Evaluating the effects of marine reserves is challenging because they occur within a context of natural spatial and temporal variation at many scales. Such effects depend on the species ecological traits and the characteristics of the reserves (e.g., design, age, enforcement, restriction level). This study examines the effects of protection on coastal species diversity, abundance and distribution (fishes, invertebrates and algae), including non-indigenous species (NIS), with different ecological traits from several marine reserves with distinct habitats, including commercial harbors, and protection regime (partial vs. total protection) based in underwater visual census, across the archipelago of the Azores, in the mid-North Atlantic. A structured hierarchical sampling design was used at several spatial scales: within an island, between islands and between island groups. Hence, the three spatial scales examined were tens of meters (sites), hundreds to thousands of meters (Islands) and hundreds of kilometers (Island Groups), through several multivariate techniques to test for and quantify multivariate variation at the different spatial scales. Coastal species communities were sampled between 2019 and 2021, conducted in the warmer months (June-October). Whenever applicable, zones with different levels of protection (i.e., the partial and total protection zones) and the unprotected neighboring areas chosen as the closest reef stretches within similar depth ranges and of similar bottom characteristics were surveyed through three replicates. Species assemblages of rocky reefs from the surface down to 40m depth were surveyed by a team of at least two scuba divers. Diver one ("mobile counts") enumerated all mobile species while a second diver ("crevice counts") would follow behind, recording all large cryptic species that typically hide in crevices and under boulders during the day, including algae. Overall, habitat had significant effects on the spatial distribution of species assemblages, reflecting positive effects of protection mainly limited to species of larger maximum size and lower mobility in reserves with higher compliance levels, according to the different exploitation levels in each Island. This result agrees with many studies elsewhere showing that reserves of small size and/or insufficient compliance do not provide adequate protection to the entire community, limiting their contribution to managing fisheries and conserving biodiversity.

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\*Speaker

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# Standardized underwater methodologies to monitor climate change effects: the Interreg MED MPA Engage project

Martina Coppari\*<sup>1</sup>, Joaquim Garrabou<sup>2</sup>, Ernesto Azzurro<sup>3</sup>, Antonio Di Franco<sup>4</sup>, Torquato Pulido Mantas<sup>1</sup>, Barbara Calcinai<sup>1</sup>, Camilla Roveta<sup>1</sup>, Cristina Gioia Di Camillo<sup>1</sup>, and Carlo Cerrano<sup>1,4,5</sup>

<sup>1</sup>Università Politecnica delle Marche – Italy

<sup>2</sup>Institut de Ciències del Mar, CSIC – Spain

<sup>3</sup>CNR-IRBIM – Italy

<sup>4</sup>Stazione Zoologica Anton Dohrn – Italy

<sup>5</sup>Fano Marine Center – Italy

## Abstract

Climate change (CC) is one of the most important issues at a global scale. Its effects are particularly evident in the Mediterranean Sea, showing a warming rate 20% faster than the world's average.

A continuous evaluation of the effects of CC can support the development of updated predictive models allowing for the design of tailored adaptive strategies by local managers.

The Interreg Med project MPA Engage involves 7 Marine Protected Areas (MPAs) and brings together a network of marine scientists, conservation and management practitioners from 6 European countries aiming to support and promote the role as nature-based solution of MPAs in the basin, implementing adaptation and mitigation strategies to face the impacts of CC.

This project assesses the effects of CC applying 11 standard protocols: 1) local ecological knowledge, LEK-1 to reconstruct historical changes; 2) LEK-2 for periodical monitoring; 3) LEK-3 for mass mortality; 4) monitoring temperature conditions; 5) assessment and monitoring of mass mortality; 6) fish visual census of climate change indicators; 7) sea urchin population (URCH); 8) benthic habitat rapid assessment (BHARA); 9) *Posidonia oceanica* fast assessment (POFA), 10) fast assessment of *Pinna nobilis* conservation; 11) photogrammetry as monitoring tool for benthic habitats structure and dynamics (SFM).

These protocols aim to evaluate the conservation status of charismatic species, in relation with the variation of temperature together with the spreading of thermophilic species, the presence of benthic alien species and the tridimensionality of the seabed. These protocols have been developed by a team of scientists with a co-creation approach, considering the practical needs of MPAs managers. The methodologies represent a sort of shared language that MPAs managers and staff can adopt after a common training. This approach aims to guarantee their long-term implementation, and a continuous comparison among MPAs.

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\*Speaker

Apart from being standard, the strength of these protocols relies on their easy implementation that can be done not only by scientists but also by citizens (e.g. diving staff or recreational divers) after receiving an appropriate scientific training.

The direct involvement of citizens supporting scientists and MPAs staff in the monitoring activities allows for the obtainment of a large spatial and temporal scale dataset, impossible to be achieved only with usual scientific monitoring. A general growth of ocean literacy in the society is also a secondary effect of the protocols' implementation.

The obtained data are shared and validated on common repositories, building robust baselines to evaluate the consequences of the CC at a local and regional scale.

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# Experimental cultivation of sponges within fish farms - assessment of growth and survival

Thanos Dailianis\*<sup>1</sup>, Emmanouela Vernadou<sup>1</sup>, Ioulios Glampedakis<sup>1</sup>, Nikos Papandroulakis, Eleni Voultziadou<sup>2</sup>, and Manolis Mandalakis

<sup>1</sup>Hellenic Centre for Marine Research, Institute of Marine Biology, Biotechnology Aquaculture – Greece

<sup>2</sup>Department of Zoology, School of Biology, Aristotle University of Thessaloniki – Greece

## Abstract

Sponges are sessile organisms with unique regeneration capacity and body plasticity. These properties render their cultivation in the open sea (sponge farming) possible, based on fragmentation into explants and their subsequent development and growth into fully functional individuals. Combined with a remarkable filtering capacity mainly targeting picoplankton and particulate or even dissolved organic load, sponges are acknowledged as highly promising candidates for bioremediation in IMTA (Integrated Multi-Trophic Aquaculture) systems, although only few studies globally have investigated this potential in practice. In the framework of the research project SPINAQUA (<https://spinaqua.hcmr.gr>), we have initiated an experimental sponge aquaculture of four Mediterranean sponge species adjacent to the pilot scale research fish farm f HCMR in Crete Island, Greece. For each examined sponge species, 50 explants have been introduced in experimental cultivation for the past 18 months and systematically monitored for survival and growth. Monitoring is performed by diving scientists at regular intervals, measuring the dimensions of the explants while at the same time recording necroses, fouling, and mortality events. Rearing infrastructure has been designed on purpose and modified over the course of the experimental setting to better fit the particular environmental requirements of the four sponge species. The obtained results showed contrasting growth patterns for the examined species, although survival remained high, with few losses of whole individuals, providing a baseline on the potential of sponge farming in the oligotrophic Mediterranean Sea environment. Combined with simultaneous laboratory studies on the filtering activity of the selected sponges on different biological substrates and chemical pollutants, this approach highlights promising candidates for bioremediation under integrated aquaculture schemes. Since aquaculture is a thriving economic sector that is expected to further increase its importance in the future under blue growth strategies, research on bioremediation and exploration of novel resources is essential to ensure sustainable development and promote environmental quality.

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# Reforesting Gyaros MPA reefs (N. Cyclades, Greece) within the LIFE REEForest initiative

Polytimi-Ioli Lardi\*<sup>1</sup>, Yiannis Issaris<sup>1</sup>, Vasilis Gerakaris<sup>1</sup>, Falace Annalisa<sup>2</sup>, and Maria Salomidi<sup>1</sup>

<sup>1</sup>Hellenic Centre for Marine Research, Institute of Oceanography, Anavyssos 19013, Attica, Greece – Greece

<sup>2</sup>University of Trieste, Department of Life Sciences – Italy

## Abstract

The uninhabited and remote island of Gyaros in the central Aegean Sea is a Natura 2000 site (GR4220033) and has been designated as a Marine Protected Area since 2016. Alarmingly, the island's shallow rocky reefs have experienced a sharp decline in the occurrence and abundance of canopy-forming macroalgae (i.e. Fucales). This issue is widespread in many regions of the Mediterranean, particularly the eastern basin, and is closely linked to the overfishing of natural predators and ensuing overgrazing by uncontrolled herbivore populations of native or non-native species. Notwithstanding, the shallow reefs of the Gyaros MPA, where bushy vegetation still persists, appear to be more robust as compared to nearby turf-dominated unprotected islands (Salomidi et al. 2022). Given the recent total ban on fisheries in this marine zone, Gyaros seems to be an ideal place to apply novel restoration techniques to replenish the island's reef biota. The first experimental *ex-situ* restoration activity was carried out in early May 2023 within the frame of the LIFE REEForest project (LIFE-2021-SAP-NAT), which is strongly aligned with the nature restoration targets set out in the EU 2030 Biodiversity Strategy. Fertile apices of *Cystoseira* s.l. brown algae species were carefully collected on site, and the recruits were cultivated in environmentally controlled mesocosms at the HCMR premises. The seedlings, grown on clay tiles, were later fixed on large concrete plates, and then outplanted at Gyaros by scuba divers at depths between 5 - 10 m. To better protect the seedlings from grazers, cages were placed above each restoration unit. Follow-up monitoring will determine whether the critical survival thresholds will be met.

Salomidi M, Lardi P, Issaris Y, Gerakaris V (2022) Collapsing coastal reefs: the case of Gyaros Marine Protected Area and the North Cyclades Isl., Aegean Sea, Greece. Marine and Inland Waters Research Symposium 2022. AKS Porto Heli Conference Center, Porto Heli, Argolida, Greece, 16-19 September 2022. Proceedings, 139-142p.

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\*Speaker



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# Artificial reefs efficiency changes among types and following coastal development, as revealed by underwater hyperspectral imagery.

Elisabeth Riera\*<sup>1</sup>, Mischa Ungerman<sup>2</sup>, Alexis Pey<sup>3</sup>, Guy Rigot<sup>2</sup>, Patrice Francour<sup>4</sup>, Cédric Hubas<sup>5</sup>, and Francesca Rossi<sup>6</sup>

<sup>1</sup>Muséum national d'Histoire naturelle – UMR BOREA 8067 – France

<sup>2</sup>Planblue – Germany

<sup>3</sup>THALASSA Marine research Environmental awareness – THALASSA Marine research – France

<sup>4</sup>Ecology and Conservation Science for Sustainable Seas (ECOSEAS) – Université Côte d'Azur (UCA) – France

<sup>5</sup>UMR BOREA – Muséum National d'Histoire Naturelle (MNHN) – France

<sup>6</sup>Ecology and Conservation Science for Sustainable Seas (ECOSEAS) – Centre National de la Recherche Scientifique - CNRS – France

## Abstract

Among their diverse objectives, artificial reefs (ARs) are considered as a tool for biodiversity and ecosystem management, but their efficiency is variable. In this paper, we used underwater hyperspectral technology to compare the benthic photosynthetic assemblages of ARs to those of natural reefs in two stretches of coastlines characterised by differential coastal development and to a 3D-printed AR. New types of 3D-printed ARs can mimic natural conditions better than the conventional ones and represent an innovative restoration opportunity. We expected that differences between ARs and natural reefs varied according to coastal development and that the assemblage of the 3D-printed AR was more similar to the assemblage of the natural reef than to the ones of old-generation AR. Our findings showed that the macroalgal cover and primary production were larger on natural than artificial reefs on the highly developed coastline and that red-brown algae characterised natural reefs in both coastlines. On the developed coastline, the assemblage of the 3D-printed AR globally resembled that of the natural reef, even though there were still some differences. Our case study offers promising results for implementing the use of 3D-printed artificial reefs in coastal reconciliation, however, their efficiency has to be monitored in contrasting situations to test their efficiency. We also found in underwater hyperspectral imaging a promising approach for non-destructive sampling of underwater habitats giving interesting results to compare benthic communities in a relatively simply and timely manner.

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\*Speaker

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# Stereo-video transect surveys for the assessment of coastal rocky fish assemblages in the Gyaros MPA in Greece.

Yiannis Issaris\*<sup>1</sup>, Vasilis Gerakaris<sup>1</sup>, George Oikonomidis<sup>1</sup>, and Maria Salomidi<sup>1</sup>

<sup>1</sup>Hellenic Centre for Marine Research, Institute of Oceanography, Anavyssos, Attika, Greece – Greece

## Abstract

Gyaros island, situated in the central Aegean Sea, Greece, was established in 2016 as a Natura 2000 (SCI/SPA) site, originally due to the presence of a large monk seal *Monachus monachus* colony. For the last 3-4 years, it has been enjoying an official total ban on all forms of fisheries being actively enforced by a robust surveillance system that encompasses full-area active radar coverage and systematic boat patrolling. In order to assess the effectiveness of the conservation measures that are been enforced in the area, and thus monitor the recovery of the coastal ecosystem in a region where overfishing has taken a great toll, continuous monitoring of the ecological state, with a special focus on coastal rocky fish assemblages, was deemed critical from the very beginning.

The common practice for assessing the coastal rocky fish assemblages of the Mediterranean Sea in a non-destructive way, especially in the case of Marine Protected Areas (MPAs), has been the application of the so-called underwater visual census (UVC) technique, that was first described in the early 70s and has remained almost unchanged in its fundamentals ever since. However, this technique has been proved to be prone to non-systematic errors, due to the very nature of the sampling process, e.g., different observers make different fish size and distance estimations, certain fish present diver avoidance or attraction behaviours that changes over time and site protection status, among others.

In the case of the monitoring of the Gyaros MPA coastal rocky fish assemblages that has been going on continuously since 2019, the stereo-video transect survey was selected as a more robust technique, addressing most of the non-systematic errors that hinder the classic surveys based on UVC. Given the high clarity of the water that is typical of the study area, a custom-designed stereo-video system comprising a stereo-video camera platform and calibration board was built for the purpose, allowing accurate estimations of object dimensions in underwater distances up to 8 metres ahead of the user, and thus more accurate estimations of fish sizes and biomass that are independent of the observer. The design of the survey also takes into consideration the effect of the varying fish behaviour in their detection and recording, and by specifying a rather fast swimming speed, tries to minimize its effect. Replication of the method is straightforward, as common, off-the-shelf materials were used to build the system, thus allowing changes in the organisation and/or team that might undertake the monitoring of the area in the future.

On the downside of this method, the stereo-video survey technique requires a disproportionate amount of time for data analysis by a fish id expert, as it specifically involves going over the videos almost frame-by-frame to check for the presence and size of every fish recorded

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\*Speaker

using a special, yet freely available, software. In time-restricted projects, this has to be taken into consideration beforehand, as fast results is not always feasible to be provided for reporting.

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# Stereo-photogrammetry tools for efficient underwater 3D data acquisition

Justine Richaume\*<sup>1</sup>, Tristan Estaque\*<sup>1</sup>, Olivier Bianchimani<sup>1</sup>, Vincent Blondeaux<sup>2</sup>,  
Margo Fargetton<sup>2</sup>, Tiffany Monfort<sup>2,3</sup>, and Adrien Cheminée<sup>1</sup>

<sup>1</sup>Septentrion Environnement – Septentrion Environnement – France

<sup>2</sup>Septentrion Environnement – Septentrion Environnement – France

<sup>3</sup>Institut méditerranéen d'océanologie – Institut de Recherche pour le Développement :  
UMR<sub>D</sub>235, AixMarseilleUniversité : UM110, InstitutNationaldesSciencesdel'Univers :  
UMR7294, CentreNationaldeRechercheScientifique : UMR7294, UniversitédeToulon :  
UMR7294 – –France

## Abstract

In order to better understand marine communities and optimize the 3D modeling and monitoring of marine habitats we developed a new photogrammetry tool named "KarKam".

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\*Speaker

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# Use of photogrammetry-based descriptors to assess the effect of 3D structure of shallow Mediterranean rocky reefs on teleost assemblages

Tiffany Monfort<sup>\*1,2</sup>, Pierre Drap<sup>3</sup>, Laura Barth<sup>2</sup>, Olivier Bianchimani<sup>2</sup>, Tristan Estaque<sup>2</sup>, Margo Fargetton<sup>2</sup>, Julien Gasc<sup>2</sup>, Lucie Nunez<sup>4</sup>, Justine Richaume<sup>2</sup>, Thierry Thibaut<sup>1</sup>, and Adrien Cheminée<sup>2,5</sup>

<sup>1</sup>Institut méditerranéen d'océanologie – Institut de Recherche pour le Développement :  
UMR<sub>D</sub>235, AixMarseilleUniversité : UM110, InstitutNationaldesSciencesdel'Univers :  
UMR7294, CentreNationaldeRechercheScientifique : UMR7294, UniversitédeToulon :  
UMR7294 – –France

<sup>2</sup>Septentrion Environnement – Septentrion Environnement – France

<sup>3</sup>Laboratoire d'Informatique et Systèmes – Aix Marseille Université : UMR7020, Université de Toulon :  
UMR7020, Centre National de la Recherche Scientifique : UMR7020 – France

<sup>4</sup>Septentrion Environnement – Septentrion Environnement – France

<sup>5</sup>Aix-Marseille Université - Faculté des Sciences – Aix Marseille Université – France

## Abstract

In the Mediterranean Sea, shallow rocky reefs and the associated three-dimensional (3D) structure support rich and abundant communities; they are therefore of functional importance, in particular for the renewal of fish stocks. However, these habitats and their functions are likely to be altered by anthropogenic pressures inducing habitat transformations. It is therefore necessary to assess their 3D structure, their transformations and relationship to communities, especially for management and conservation purposes. In this study we aimed (i) to compare two methods that quantify the metrics of the 3D structure (rugosity) of shallow rocky reefs (chain-and-tape method and photogrammetry), and (ii) to quantify the possible links between this habitat structure and the fish assemblages. Moreover, (iii) a third part of the study extended the study of habitat structure effect on assemblages by including as well the potential effect of both protection (in versus out no-take zones) and geographical localization (Corsica vs Provence). We found that photogrammetry and the chain-and-tape method yielded a similar estimate of rugosity, but photogrammetry was the most efficient method in terms of measurement quality and time (when considering in-water acquisition). This method also displayed the best repeatability. The 3D habitat descriptors (mean surface rugosity, variation of surface rugosity, and depth) differed significantly between the studied sites and were therefore included as covariables. Inside the Calanques National Park (Provence), total fish abundance and species richness increased with higher mean surface rugosity. In addition, the composition of fish assemblages was significantly influenced by surface rugosity, although this effect was modulated by depth. When focusing on specific taxa, neither density patterns nor size class distributions displayed clear patterns in relation to rugosity metrics. As preliminary conclusions, our study has shown (i) that photogrammetry is an appropriate method to assess 3D structure metrics in a temperate rocky reef.

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\*Speaker

Moreover, (ii) this study demonstrated that spatial variability of teleost fish assemblages can be explained by habitat rugosity which probably increases the number of shelters and food resources, and therefore improves chances of survival. Finally, (iii) the potential interaction effects of 3D structure with protection level and localization will be quantified through complementary field work currently being performed for this third objective.

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# Assessment of biodiversity and checklist of demersal fish species in a ghost net affected area, Tyrrhenian Sea, Sicily, Italy

Andrea Spinelli<sup>\*1</sup>, Dyana Vitale<sup>2</sup>, and Carlos Taurá<sup>3</sup>

<sup>1</sup>Research Department, Fundació Oceanogràfic de la Comunitat Valenciana, Oceanogràfic, Ciudad de las Artes y las Ciencias, 46013, Valencia, Spain – Spain

<sup>2</sup>Environmental and Food Safety Research Group (SAMA-UV), Desertification Research Centre (CIDE), Universitat de Valencia-CSIC-GV, Moncada-Naquera Road Km 4.5, 46113, Moncada, Valencia, Spain – Spain

<sup>3</sup>Oceanogràfic de la Comunitat Valenciana, Ciudad de las Artes y las Ciencias, 46013, Valencia, Spain – Spain

## Abstract

Every year, around 640 thousand tons of ghost nets are globally generated in the oceans, representing about 10 percent of the world's marine plastics, according to the annual reports of the United Nations Environment Program (Macfaydyen et al., 2009) and the data may be increasing. Ghost fishing net cover ever larger areas of oceans, and can affect marine fauna, from megafauna (e.g. turtles, dolphins, whales) to fish and benthic communities, damaging the coastal ecosystems (Gilman, 2015; Gilman, 2016; Beneli et al., 2020). The effects of this phenomenon can be considered negative, causing the deaths of many wild animals, and negatively affecting the fish stock assessment models (Link et al., 2019, Gilman, 2016). In Mediterranean is known that the ghost nets affected a different aquatics group, causing negative effects at marine biodiversity (Howard et al., 2012; Perroca et al., 2022). Italy is a one of the countries with the largest number of ghost fishing record from the Mediterranean, first among the 12 countries analyzed in a recent study (Perroca et al., 2022). The underwater monitoring technique using "Visual Census" represents a sampling methodology widely used in the ecological studies (Montefalcone et al., 2017). The effects at marine biodiversity have been studied in a ghost net affected area, Tyrrhenian Sea, Sicily, Italy. A preliminary study has been conducted to evaluate the diversity and abundance of demersal fish in Bank of Campanari, Cefalù, Tyrrhenian coast, Italy from August 2021, with presence of ghost nets and August 2022, one year after the ghost nets has been removed. Demersal fish samples have been collected from two different stations using the Underwater Visual Census (UCV) method (Labrosse et al, 2002). Descriptions of demersal fish community has been performed in horizontal belt-transects of 25x5x5 (Labrosse et al., 2002). Some specimens have been photographed in situ to document alive coloration and small-scale habitat features. Demersal fish community study has been quantitative descriptive. We calculated the dominance the diversity index (H) and the abundance of total fish community in the study area, in according with Labrosse et al., method (2002). We identified 22 species of fish from 10 families. Two of the species observed are classified as endangered or vulnerable in the list of International Union for Conservation of Nature (IUCN 2021). Sparidae family was the dominant family of

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\*Speaker

demersal fish community in the study area. The dominance index value (H) in 2021 showed a low category, and in 2022 the fish diversity increased, with a dominance index (H) medium. The highest abundance of demersal fish in the study area has been detected in august 2022, one year after the ghost nets removed. The results of this study can provide important input for the assessment of ghost nets impact at marine biodiversity, in the Mediterranean region.



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# The cold side of climate change. Diver supported shallow water observatory operation in the Arctic.

Fischer Philipp\*<sup>1</sup>

<sup>1</sup>Alfred Wegener Institute for Polar and Marine Research – Germany

## Abstract

A thorough and reliable assessment of changes in Essential Ocean Variables is most important for understanding the effects of global change on long-term trends in marine ecosystems and their communities. This is especially true for polar areas which are well known as predictors for future global climate scenarios. The Alfred-Wegener-Institute Centre for Scientific Diving operates cabled shallow water observatories in both, polar and boreal areas allowing for a year-round 365/34 assessment of EOVS and associated biological communities. The shallow water observatory in NyAlesund (Svalbard) is one of the core stations of the AWI underwater node network and is fully maintained by scientific divers year-round. The observatory provide unique insights in the seasonal changes of the main EOVS and shallow water biological community. The observatory was completely renewed in a 3-week dive mission in January 2022 including an upgrade of the stereoscopic fish-observatory. In the talk, long term changes in the EOVS temperature, salinity, oxygen, chlorophyll a and turbidity as well as changes in the jellyfish and fish community are presented. The main focus of the analysis is laid on the effects of extreme values in the measured EOVS during the period 2012 to 2021 and their effects on the jellyfish and fish community as well as the challenges of a year-round long-term operation of a shallow water cabled observatory in an Arctic area.

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# Diverse diving discoveries – from an 18th century cannon to nodules of white phosphorus

Minna Koivikko\*<sup>1</sup>

<sup>1</sup>The Finnish Heritage Agency – Finland

## Abstract

Archaeological excavations as a case study at a UNESCO World Heritage Site, the Suomenlinna Sea Fortress Our study site is the Suomenlinna island fortress on the northern shores of the Gulf of Finland. The fortress is a UNESCO World Heritage site with a fascinating underwater cultural heritage. We organised archaeological excavations for a wooden skeleton wreck and a cannon site, on the southern shoreline of the fortress island. This excavation campaign belongs to the project called "End of Glory Days, Biography of the Swedish wrecks as Blue Heritage of Suomenlinna," which is a subproject to "The Lost Navy" research program. The program runs from 2021-2026 and is a collaboration between the Centre for Maritime Studies at Stockholm University, the Swedish National Maritime and Transport Museums, and the Finnish Heritage Agency. Our project concentrates on the wooden wrecks of the navy from the Finland's Swedish period (before 1809). The challenges for the underwater study include: its geographical location near a river mouth, low public awareness because these wooden wrecks are invisible to everyday life, and the yet unknown effects of forthcoming climate changes, especially in which ways these changes will affect the sea and underwater cultural heritage. In addition, there are other challenges and possible dangers when excavating an old military fortress, which create risks for scientific diving. Within this presentation, I am going to share the findings and foresights of running the excavation campaign

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\*Speaker

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# The usage of virtual and augmented reality in underwater archeology

Kinga Korniejenko\*<sup>1</sup>

<sup>1</sup>Cracow University of Technology – Poland

## Abstract

The aim of the research is to analyze the possibilities of using virtual and augmented reality technologies in the broadly understood activity related to underwater archaeology. The article is a review and presents current applications of virtual and augmented reality in underwater archeology based on case studies. The paper presents the development of virtual and augmented reality technologies, describes the general process of creating a virtual or augmented reality application for the purposes of underwater archaeology, with particular emphasis on data collection methods. Then, the general areas of application of these technologies in underwater archeology and related areas are presented, and the barriers to their use are discussed. The most important part of the paper is a discussion of the use of augmented and virtual reality in underwater archeology based on selected case studies. The article ends with a summary of the current state and a discussion of the possibilities of developing these technologies in the applications of underwater archaeology.

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# Modern Wrecks in the Greek Seas. Documentation, Promotion, Challenges

Kimon Papadimitriou\*<sup>1</sup>

<sup>1</sup>Aristotle University of Thessaloniki, Faculty of Engineering, Laboratory of Topography, School of Rural and Surveying Engineering, 54124 Thessaloniki, Greece – Greece

## Abstract

Underwater Survey Team (UST) at Aristotle University of Thessaloniki, is a citizen science - oriented initiative which is based on the collaboration of academic staff with the diving community, towards the research, the documentation, the study and the promotion of maritime tangible or intangible particularities. Since 2018, UST is taking over information and awareness of public, especially on matters related to modern wrecks ([www.wreckhistory.com](http://www.wreckhistory.com)). The specialized scientific diving training courses and research activities, coordinated by UST members are aiming to a safe and responsible approach of the underwater natural and cultural heritage.

Beginning the 3rd of March 2022, a joint ministerial decision (No. 92225) regulates for first time in Greece the accessibility at 91 historical wrecks of ships and aircrafts, most of them from the second world war (WW2). A primary assessment for the losses in the Greek seas during the WW2 period (1939-1945), lists more than 1000 ships, while a rough estimation for the total number of modern wrecks (after 1830), exceeds 2500 vessels. The documentation of those underwater cultural assets, which relies on both archival research and in-situ surveys, is translated into a hard to accomplish task considering the ambiguities that arise from the misinterpreted data derived during the turbulent era of warfare, as well as the fact that a vast (unknown) number of wrecks (particularly those in shallower depths) have been recovered to be sold as scrap metal. Wrecks, being a major attraction for the divers (but also for the marine life), also deserve recognition from the general public since their historical cargos have been interlaced with people lives (letting alone the interaction of their materials with the environment). The promotion of this submerged (hidden for most of the population) heritage is emerging not only as a trend in the tourism industry, but rather as a necessity for our cultural identity and for the sustainable stewardship of sea in the modern times of Ocean Literacy.

This paper aims to showcase the challenges, that UST is facing, in this new (for the diving community) status regarding the modern wrecks in the Greek seas. The work presented here is a result of independent unfunded research in the context of the UST's activities.

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# Using three-dimensional photogrammetry to investigate effects of structure on shipwreck-associated communities

Peter Almond\*<sup>1</sup>, Rachael Priest<sup>1</sup>, Clare Fitzsimmons<sup>1</sup>, and William Reid<sup>1</sup>

<sup>1</sup>School of Natural and Environmental Sciences, Newcastle University – United Kingdom

## Abstract

Shipwrecks, as artificial reefs, are unique seafloor habitats, promoting benthic settlement, abundance and diversity through their provision of hard, complex substrate to habitats which may otherwise lack these features. As marine habitats, shipwrecks are unique due to their degradation and reduction in complexity over time. In a North Sea context, where the seabed has been altered over 250 years of overfishing and disease into a mostly mud-dominated, soft sediment habitat, shipwrecks provide structure for species that may have seen their ranges significantly depleted. The North-East coast of England, specifically, has a high number of wrecks due to the unique industrial, historic and cultural heritage of the region. Structure-from-motion, three-dimensional photogrammetry as a method for investigating trends in biology and ecology is increasingly cost effective, and in recent years has been applied to marine environments to answer a range of ecological questions. The ability to capture detailed and accurate models of large structures efficiently using photogrammetric methods has made shipwrecks an ideal target for this. In-situ diver video surveys were conducted across shipwrecks off the North-East coast of England in the north-western North Sea, and all visible organisms were counted and identified to lowest possible taxonomic level. Using the photogrammetric pipeline, information on fine-scale structural complexity could also be ascertained from the video transects. Benthic community structure was analysed in the context of wreck-specific factors such as age, depth and material. Communities were found to differ between regions and specific wrecks. More structurally complex wrecks hosted higher abundances and diversity, likely through the provision of greater space for settlement and ecological niches. Results can also be used to infer how communities may change as shipwrecks continue to break-down over time, and how this may influence the wider ecosystem. Shipwrecks sit at the crossover of ecological, cultural and historic interest, providing value for all three. As any management decision regarding the protection of these historically significant sites has to take into account these conflicting interests, highlighting the unique role that wrecks have on the ecosystem can have implications for policy and management decisions moving forwards.

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\*Speaker

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# Shipwrecks: The Overlooked Ecosystems

Rachael Priest\*<sup>1</sup> and Clare Fitzsimmons

<sup>1</sup>School of Natural and Environmental Sciences, Newcastle University – United Kingdom

## Abstract

Deep oceans, seagrass beds, mudflats, and mangroves are examples of marine ecosystems that provide us with essential services. These services include carbon capture, coastal protection, and food provision, but with the growing human population, increasing demands are being placed on the marine environment and the services that it provides. As such, it is important that we are able to quantify and assess marine services to ensure sustainable management. One marine service that is often overlooked, is offered by shipwrecks. Tens of thousands of shipwrecks litter the UK coast, providing sanctuary to marine species. This has implications for biodiversity and carbon storage on shipwreck sites, but it is unclear to what extent shipwrecks impact the distribution of local benthic species. In this work, we show the distribution of a single benthic species across several shipwrecks, from the historic scuttling of the German Fleet in Scapa Flow, Scotland. Results indicate that the influence of shipwrecks extends beyond the wreckage and radiates out into the seabed. Whilst shipwrecks are known to be biodiversity hotspots, there is a need for more in-depth understanding of the benthic seafloor surrounding them. This research broadens the services that shipwrecks offer and highlights the need to include them as ecosystem services.

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\*Speaker

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# European standards for initial training in scientific diving, a necessity, and a guarantee for the mobility of scientists and effective research in the coastal environment

Jean-Pierre Féral\*<sup>1</sup> and Alain Norro<sup>2</sup>

<sup>1</sup>Institut méditerranéen de biodiversité et d'écologie marine et continentale (IMBE) – INEE, Université d'Avignon et des Pays de Vaucluse, Institut de recherche pour le développement [IRD] : UMR237, Aix Marseille Université, CNRS : UMR7263, INSB, INSU – Aix Marseille Université, Station Marine d'Endoume, Chemin de la Batterie des Lions, 13007 MARSEILLE, France

<sup>2</sup>Royal Belgian Institute of Natural Sciences (RBINS), Bruxelles – Belgium

## Abstract

Getting diving recognised as a scientific technique has long been a challenge in most European countries because of the "recreational" image associated with its practice. Another important difficulty for its administrative acceptance has been its supposed danger and the chain of responsibilities that an accident could initiate.

As early as the 1980s, it was understood that an essential aspect of making underwater interventions possible in the various scientific disciplines that needed them was the definition and implementation of an initial training that would guarantee maximum safety. A framework at least at European level was necessary to allow scientists from several countries to collaborate and therefore to allow their mobility. The scientific community was mobilised. The most difficult and important task was to set up a representative committee and to define harmonised standards, acceptable and recognised by the Member States. A long process (late 1980's - 2000's) led to the proposal to establish European standards for scientific diving and to make visible a "European Scientific Diving Panel" through the ESF Marine Board between 2008 and 2017. This panel is currently receiving organisational support from the European Network of Marine Institutes and Stations (MARS).

This effort finally led to the acceptance and development of two European standards for scientific diving: the European Scientific Diver standard (ESD) and the Advanced European Scientific Diver standard (AESD). Currently, 17 countries recognise and apply these standards (or equivalent). The quality and general acceptance of these standards by a large part of the European scientific community has led to their adoption in the health and safety legislation of 7 European countries (BE, DE, FI, FR, NO, SE, UK). A similar legal process is underway in several other countries.

These standards have been defined in the context of the *occupational* practice of professional scientists. However, the use of the term "scientific diving" in the world of recreational diving, which does not follow the same rules of professional training and is aimed at volunteers, is currently blurring the original concept of scientific diving. An urgent clarification is needed

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\*Speaker

to differentiate between scientific activity and citizen science, which does not require the same scientific and technical skills, despite the use of similar equipment. The (semantic) confusion created by the indiscriminate use of the same terms to refer to different training and activities risks compromising these years of effort and diminishing the quality of ESD and AESD standards, which are often considered too high and restrictive by the recreational diving sector willing to develop with ISO their own standards, keeping the same wording "scientific diving" but with a "citizen science diver" content. Be warned !



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# Nature based mooring systems, to involve recreational divers in citizen science programs and increase awareness on conservation of temperate reef ecosystems

Valentin Danet<sup>\*1</sup>, Frédéric Ysnel<sup>2</sup>, Pierre Thiriet<sup>3</sup>, Quentin Ternon<sup>4,5</sup>, Matthieu Dufeu<sup>6</sup>, Nassim Sebaibi<sup>6</sup>, and Eric Feunteun<sup>5,7,8</sup>

<sup>1</sup>Museum National d'Histoire Naturelle (MNHN), Station Marine de Dinard, Centre de Recherche et d'Enseignement sur les Systèmes CÔtiers (CRESCO), Dinard, France – Muséum National d'Histoire Naturelle (MNHN) – France

<sup>2</sup>Université de Rennes 1, UMR BOREA, MNHN, 35042, Rennes Cedex, France – université Rennes 1 – France

<sup>3</sup>UMS Patrimoine Naturel, OFB, CNRS, MNHN, CRESCO, Dinard, France – UMS PatriNat – France

<sup>4</sup>Museum National d'Histoire Naturelle (MNHN), Station Marine de Dinard, Centre de Recherche et d'Enseignement sur les Systèmes CÔtiers (CRESCO), Dinard, France – Muséum National d'Histoire Naturelle (MNHN) – France

<sup>5</sup>Laboratoire Biologie des Organismes et Écosystèmes Aquatiques (UMR BOREA), MNHN, CNRS, Sorbonne Université, Université de Caen Normandie, Université des Antilles, IRD, Paris Cedex, France – UMR BOREA 7208 – France

<sup>6</sup>Ecole Supérieur d'Ingénieurs des Travaux de la Construction, Caen, France – Ecole Supérieur d'ingénieurs des travaux de la construction (ESITC CAEN) – France

<sup>7</sup>Museum National d'Histoire Naturelle (MNHN), Station Marine de Dinard, Centre de Recherche et d'Enseignement sur les Systèmes CÔtiers (CRESCO), Dinard, France – Muséum National d'Histoire Naturelle (MNHN) – France

<sup>8</sup>Centre de Géo-Écologie Littorale (CGEL), EPHE-PSL, Dinard, France – École Pratique des Hautes Études [EPHE] – France

## Abstract

The Dinard marine station of the MNHN has designed and developed, within the framework of the European MARINEFF program, an ecosystem-based mooring that is designed to mimic natural temperate reefs. Associated with this artificial reef, a floating mooring, made of textile, helps limiting abrasion of the chains on the reef and on the bottom. In addition, access to the site is made easier and safer for the divers. They are deployed in highly frequented diving spots, in order to avoid anchoring thus limiting subsequent impacts. The ecosystem-based reefs were designed to concentrate a high diversity and complexity of habitats that are found in surrounding ecosystems in order to host a high diversity of sessile and mobile species. It thus represents a hot-spot of biodiversity that acts as a sampling tool to survey environmental variability and that is attractive for scuba biologists and academic

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\*Speaker

researchers. Divers were involved in a citizen science program to monitor the colonization of the reefs and to assess its influence on the surrounding natural environment. In parallel, we have deployed a survey using photogrammetry to monitor the colonization process of the ecosystem-based-reefs. Four MARINEFF moorings were immersed in the Bay of St Malo, France, in the autumn of 2020 and have been regularly monitored by citizen divers since the spring of 2021. During the talk we will present and compare the first results of the surveys.

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# A Mediterranean ‘VIT-Reef’ diving protocol for monitoring a Sea under siege

Thibaut De Bettignies<sup>\*1,2</sup>, Lucie Vanalderweireldt<sup>3</sup>, Marie Launay<sup>4,5</sup>, Grégoire Moutardier<sup>6</sup>, Vanina Pasqualini<sup>5,7</sup>, Eric Durieux<sup>5,7</sup>, and Line Le Gall<sup>8</sup>

<sup>1</sup>Laboratoire Ecologie Fonctionnelle et Environnement, CNRS, ENSAT - Avenue de l'Agrobiopole, 31326, Castanet-Tolosan, France – Laboratoire Ecologie Fonctionnelle et Environnement, Université de Toulouse, CNRS, Toulouse INP, Université Toulouse 3 - Paul Sabatier, France – France

<sup>2</sup>Service Patrimoine Naturel (OFB-CNRS-MNHN), Muséum national d'Histoire naturelle, 36 rue Geoffroy Saint-Hilaire, 75005 Paris, France – Service Patrimoine Naturel (OFB-CNRS-MNHN) – France

<sup>3</sup>Sciences Pour l'Environnement, UMR CNRS, Università di Corsica Pasquale Paoli, 20250 Corte, Corse, France – Université de Corse Pasquale Paoli – France

<sup>4</sup>Natural Resource Sciences, McGill University, 2111 Lakeshore Road, Ste-Anna-de-Bellevue, QC, H9X 3V9, Canada – Canada

<sup>5</sup>Sciences Pour l'Environnement, UMR CNRS, Università di Corsica Pasquale Paoli, 20250 Corte, Corse, France – Université de Corse Pasquale Paoli – France

<sup>6</sup>Parcs naturels marins de Mayotte (OFB), Centre d'affaires de l'aéroport, Aéroport de Mayotte, 97615 Pamandzi, Mayotte, France – Office Français de la Biodiversité (OFB) – France

<sup>7</sup>Stella Mare, UAR, CNRS, Università di Corsica Pasquale Paoli, Lido de la Marana, Lieu-dit U Casone, 20260 Biguglia, Corse, France – Université de Corse Pasquale Paoli – France

<sup>8</sup>Institut de Systématique, Evolution, Biodiversité, Muséum national d'Histoire naturelle, CNRS, Sorbonne Université, EPHE, Université des Antilles, 57 rue Cuvier, 75005 Paris, France – Muséum National d'Histoire Naturelle (MNHN) – France

## Abstract

In the Mediterranean Sea, the semi-enclosed nature of the basin and the accumulation of coastal anthropogenic pressures threaten temperate reefs resilience. Together with the spread of reef ‘tropical invaders’ like *Caulerpa cylindracea*, these ongoing pressures are supporting the so-called expression *Mediterranean is a sea under siege*. Despite some effort being put towards the development of multi-integrated indicators, many gaps still remain in reefs monitoring and description of reference conditions. Providing MPA managers and citizen science NGOs with easy-to-deploy operational diving protocol is frequently advanced to fulfil these gaps. Building from this statement, the biodiversity inventory program ‘La Planète Revisitée’ lead by the French Natural History Museum has put forward a complementary approach known as rapid assessment survey (RAS) for a closed list of 70 indicative benthic species. This Visual Inventory in Limited Time-space for Mediterranean temperate Reefs (VIT-Reef) is a semi-quantitative inventory implemented by two divers, exploring 150 m<sup>2</sup> in less than 30 minutes. The development and deployment of VIT-Reef were pursued within the three largest MPAs of Corsica, supposedly representative of pristine conditions,

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between 2019 – 2021. We will present the VIT-Reef methodology, its preliminary results and further discuss its implementation at larger scale to fulfil knowledge gaps in reefs ecological state assessment and monitoring.

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# What's going on at the core of the Coral Triangle? Results from 10 years of Reef Check and Coral Watch monitoring

Eva Turicchia\*<sup>1,2</sup>, Gianfranco Rossi<sup>2</sup>, Carlo Cerrano<sup>2,3</sup>, Daisy M Makapedua<sup>4</sup>, Markus T. Lasut<sup>4</sup>, Jane Mamuja<sup>4</sup>, Leo Chan<sup>5</sup>, and Massimo Ponti<sup>1,2</sup>

<sup>1</sup>University of Bologna – Italy

<sup>2</sup>Reef Check Italia Onlus – Italy

<sup>3</sup>Polytechnic University of Marche – Italy

<sup>4</sup>Sam Ratulangi University – Indonesia

<sup>5</sup>City University of Hong Kong – Hong Kong SAR China

## Abstract

Coral reefs health is declining worldwide being increasingly threatened by multiple stressors. These include the decline in water quality, overexploitation of resources and global climate change, which have all been linked with the onset of mass coral bleaching and diseases. Preventing further decline and maintenance of resilience of these habitats require the implementation of appropriate and timely ecosystem-based management actions, which rely on targeted long-term and integrated monitoring programs. 10-year application of Reef Check and Coral Watch community-based monitoring programs provide baseline knowledge around Bangka and Gangga Islands, at the northern tip of Sulawesi, Indonesia, between the Celebes Sea and the Molucca Sea. Here, since 2011, annual monitoring was applied at six study sites at 6 and 12 m depth, below mean lower low water. A measure of the percentage of the seabed covered by different substrate types, including live and dead coral, was done along four 20 m sections of a 100 m transect; while invertebrate counts over four, 20 m x 5 m belts along the transect; and fish counts, up to 5 m above the same belt. Bangka and Gangga Islands, being at the core of the Coral Triangle, are supposed to hosts some of the healthiest and most diverse coral reefs on Planet Earth. However, study sites are affected by some local impacts, such as destructive artisanal fishing, and are threatened by growing tourism. The environmental risks of a new mine on Bangka Island have been averted for now thanks to the growing awareness of the local population and the commitment of tourism managers that supported the authorities in enforcing the law. Since its inception, Reef Check Tropical protocol has focused on the abundance of indicator coral reef organisms, which best reflect the condition of the ecosystem and are easily recognisable to the public. The selection of these organisms was based on their economic and ecological value, their sensitivity to human impacts and ease of identification. Coral Watch developed the Coral Health Chart in 2002. Based on standardised colours, the chart provides a simple way for people to quantify coral bleaching. The two monitoring methods seem complementary and provide robust and consistent results. The integration of these approaches and the involvement of local people and stakeholders have proved to be effective in providing scientifically sound data and increasing public awareness. However, conservation actions must be strengthened, and attention kept high in the area.

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# Tridacnid clam status in Indonesia from two decades of Reef Check survey data (1997-2017)

Abigail Moore\*<sup>1,2</sup>, Syafyudin Yusuf<sup>1,2</sup>, Naneng Setiasih<sup>3</sup>, Derta Prabuning<sup>3</sup>, Abdullah Habibi<sup>3</sup>, and Samliok Ndobe<sup>4</sup>

<sup>1</sup>Hasanuddin University – Indonesia

<sup>2</sup>Association of Diving Schools (ADS-Indonesia) – Indonesia

<sup>3</sup>Reef Check Indonesia – Indonesia

<sup>4</sup>Tadulako University – Indonesia

## Abstract

Indo-Pacific tridacnid clams are heavily exploited throughout much of their range. Indonesia gave all native tridacnid species fully protected status under regulation PP No. 7/1999; however, under Ministerial Regulations P.20/MENLHK/SETJEN/KUM.1/6/2018 and P.92/MENLHK/SETJEN/KUM.1/8/2018 this protection was rescinded for the genus *Tridacna*; only *Hippopus hippopus* and *H. porcellanus* are still protected. Reef Check is a widely-used citizen science protocol for collecting data on coral reef health, with tridacnid clams as one of the indicators. Reef Check surveys are conducted by teams of divers from a wide variety of backgrounds who have been trained to use the methods and are led by a scientist with appropriate qualifications. We analysed two decades of data (1997-2017) on tridacnid clam abundance collected during Reef Check surveys across Indonesia. We found a statistically significant ( $p < 0.05$ ) decline in abundance over time, as well as differences between ecoregions (Sundaland, Wallacea and the Sahul Shelf/Bird's Head Seascape) and seaways. Clam abundances were highest in Tomini Bay and the Bird's Head Seascape. Combined with data from other sources, Reef Check size data for the decade 2008-2017 indicate that the locally abundant boring clam *T. crocea* was the most common species observed; however, exploitation of this species presents a significant risk to coral reef ecosystem integrity. Most surveyed tridacnid clam populations appear to be at risk of extirpation or ecological extinction across Indonesia. We conclude that protection for these species should be reinstated and accompanied by interventions designed to promote recovery of tridacnid clams, especially the largest species, *T. gigas* and *T. derasa*.

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# PARTICIPATORY SCIENCE IN DIVING AT THE SERVICE OF THE ASSESSMENT OF THE RESERVE EFFECT (POCTEFA RESMED PROJECT)

Philippe Lenfant\*<sup>1</sup>, Claire Bedrossian\* , Kévin Pincon , Gilles Saragoni , Martin Desmalades , Marion Jarraya , and Bernat Hereu

<sup>1</sup>Université de Perpignan Via Domitia, Centre de Formation et de Recherche sur les Environnements Méditerranéens, UMR 5110 CNRS-UPVD-CEFREM – Université de Perpignan Via Domitia, Centre de Formation et de Recherche sur les Environnements Méditerranéens, UMR 5110 CNRS-UPVD-CEFREM – 52 Avenue Paul Alduy, 66860, Perpignan, France

## Abstract

The POCTEFA RESMED cross-border project aims to improve knowledge of marine ecosystems in order to harmonize the management of marine protected areas and fisheries on both sides of the Franco-Spanish border. The objective is, in the future, to deploy this approach in other areas of the Mediterranean in order to better preserve the natural heritage, marine resources and sustainable human activities. Knowledge of the environment comes from scientific monitoring carried out by research teams. To supplement this data, scientists are enlisting the participation of recreational divers to collect additional data. This is part of the process of involving citizens in research programs. These observations reflect the state of health of the sea while stimulating diving trips. In total, sixteen diving clubs in Eastern Pyrenees and three associative clubs in Occitanie (France) took part in diving visual counts at around twenty different sites. The six species of fish selected for the counts are *Epinephelus marginatus*, *Sciaena umbra*, *Dentex dentex*, *Sparus aurata*, *Dicentrarchus labrax* and *Diplodus cervinus*. The protocol is simple, count the fishes and estimate their size along a five-minutes transect (which is about fifty meters in length) at a depth of between ten and twenty meters. This is done a minimum three times during a dive. In all, there were seventy participants in 2020 for a total of 889 fish counted and ninety-eight participants in 2021 for 1120 fish counted. Counts were conducted inside and outside the marine nature reserve of Cerbere Banyuls to measure the positive effects of the marine reserve. The results are consistent with the scientists' counts. In addition, in areas outside the reserve, these counts are complementary because they have enabled the observation of rare species such as grouper and corb.

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# European best practice for using Closed-Circuit Rebreather for Scientific diving at work. The ESDP consultation document

Alain Norro\*<sup>1</sup>

<sup>1</sup>Royal Belgian Institute of Natural Sciences (RBINS), Bruxelles – Belgium

## Abstract

Nowadays, the use of closed-circuit rebreathers (CCR) is getting more and more common. At the same time and for occupational activities like scientific diving at work, their use is still forbidden or at least restricted by legislation and/or best practice codes. In some countries like Belgium and more recently France they are today fully accepted and used for scientific diving at work.

At the European Scientific Diving panel, we decided two years ago to establish a working group on best practices for using closed-circuit rebreathers for scientific diving at work. Since we recognise the importance of taking advantage of the knowledge existing inside our occupation scientific diving sector instead of basing our use of CCR on technical diving rules, we included highly qualified scientific diver already mastering the technique for a long time as well as one rebreather manufacturer. Unfortunately, the 2020 and 2021 sanitary situations did not help the organisation, and we did the work during online meetings. The European Scientific Diving Panel issued the final document that will be presented here during fall 2021. It contains recommendations and best practice rules for using the Closed-Circuit Rebreather in the context of occupational scientific diving. The document is seen as a working document and will be updated from time to time as soon as it is necessary.

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# Challenging issues for the study of the mesophotic ecosystems by environmental DNA metabarcoding

Régis Hocdé<sup>\*1</sup>, Camille Albouy<sup>2</sup>, Olivier Bianchimani<sup>3</sup>, Tony Dejean<sup>4</sup>, Agnès Duhamet<sup>1</sup>, Dorian Guillemain<sup>5</sup>, Bastien Merigot<sup>1</sup>, Loïc Péliissier<sup>2</sup>, Romane Rozanski<sup>2</sup>, Quentin Schull<sup>6</sup>, Laure Velez<sup>1</sup>, Frédéric Zuberer<sup>5</sup>, and David Mouillot<sup>1</sup>

<sup>1</sup>MARBEC, Univ Montpellier, CNRS, Ifremer, IRD, Montpellier, France – MARBEC, Univ Montpellier, IRD, IFREMER, CNRS, Montpellier, France. – France

<sup>2</sup>Department of Environmental Systems Sciences, Landscape Ecology, Institute of Terrestrial Ecosystems, ETH Zürich, Zurich 8092, Switzerland – Switzerland

<sup>3</sup>Septentrion Environnement, Marseille, France – Septentrion Environnement, Marseille, France – France

<sup>4</sup>Spygen, Le-Bourget-du-Lac, France – SPYGEN [Le Bourget-du-Lac] – France

<sup>5</sup>OSU Pytheas, Aix Marseille Univ, CNRS, INRAE, IRD, Marseille, France – Aix Marseille Université, CNRS, Université de Toulon, IRD, OSU Pythèas, Mediterranean Institute of Oceanography (MIO), UM 110, 13288, Marseille, France – France

<sup>6</sup>MARBEC, Univ Montpellier, CNRS, Ifremer, IRD, Sète, France – MARBEC, Univ Montpellier, IRD, IFREMER, CNRS, Montpellier, France. – France

## Abstract

The mesophotic zone, defined approximately from 30 to 150m depth, covers various ecosystems in coral, temperate or cold zones. These ecosystems are areas of interest for several reasons. The low light, the rather constant sea water temperature, the less energetic conditions than the subsurface constitute specific conditions. The communities present are also specific. The mesophotic zone is moreover less under pressure, and constitute a refuge zone on the scale of global changes, but they remain understudied (Pyle and Copus 2019). Environmental DNA metabarcoding has demonstrated its performance in the marine environment to evaluate different taxa (Deiner et al. 2017). If the study of the subsurface by light methods (Polanco et al. 2020) and the study of the deep sea by very heavy resources requiring oceanographic vessels, rosette and niskin or pumps (McClenaghan et al. 2020), the ways to study the mesophotic zone remained a challenge. Several methods have been tested in deep and mesophotic marine environments, especially in rocky and coral areas, including with deep rebreather divers (Juhel et al. 2020, 2022, Muff et al. 2022). A method has been developed to respect the developed standardized protocol based on a large volume (Polanco et al. 2020, Stauffer 2021), to catch the best "signal" close to the substrate, with a dynamic filtration to be integrative of the sampled area, taking care of the safety of the diving scientists. This method is based on transects at different depths, carried out by deep divers with CCR rebreathers using scooters and double submersible pumps specifically developed. This method is deployed at a quarterly frequency on two mirror sites in the Mediterranean Sea in the Calanques of Marseille in a protected 'no take' zone and outside since two years. Being the first eDNA-based observatory of the mesophotic zone for the study of vertebrate and invertebrate communities. the longitudinal dimension of the acquired data will make it possible to understand the trend evolutions as well as the variations of the seasonal cycles.

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# Monitoring the plasticity and resilience of gorgonians in the Mediterranean sea. A case study in the Calanques National Park (Marseille).

Quentin Schull\*<sup>1</sup>, Olivier Bianchimani<sup>2</sup>, Tristan Estaque<sup>2</sup>, Justine Richaume<sup>2</sup>, Didier Aurelle<sup>3</sup>, Marc Bally<sup>3</sup>, Jean-Baptiste Ledoux<sup>4</sup>, Joaquim Garrabou<sup>5</sup>, Laura Barth<sup>2</sup>, Giulia Gatti<sup>2</sup>, Mohammad Motasem Nawaf<sup>6</sup>, Pierre Drap<sup>6</sup>, Solène Basthard-Bogain<sup>2</sup>, Vincent Blondeaux<sup>2</sup>, Adrien Cheminée<sup>2</sup>, Stéphane Sartoretto<sup>7</sup>, Régis Hocdé<sup>8</sup>, and Bastien Mériçot<sup>8</sup>

<sup>1</sup>MARine Biodiversity Exploitation and Conservation – Institut de Recherche pour le Développement, Institut français de Recherche pour l’Exploitation de la Mer, Université de Montpellier, Centre National de la Recherche Scientifique – France

<sup>2</sup>Septentrion Environnement, Marseille, France – Septentrion Environnement, Marseille, France – France

<sup>3</sup>Institut méditerranéen d’océanologie – Institut de Recherche pour le Développement, Aix Marseille Université, Institut National des Sciences de l’Univers, Université de Toulon, Centre National de la Recherche Scientifique – France

<sup>4</sup>Centro Interdisciplinar de Investigação Marinha e Ambiental - CIIMAR, Porto, Portugal – Portugal

<sup>5</sup>Instituto de Ciencias del Mar (ICM) - CSIC, Barcelona, Spain – Spain

<sup>6</sup>Laboratoire d’Informatique et Systèmes - LIS, Univ Aix-Marseille, CNRS, France – Laboratoire d’Informatique et Systèmes - LIS, Univ Aix-Marseille, CNRS, France – France

<sup>7</sup>IFREMER, La Seyne sur Mer, France – IFREMER, La Seyne sur Mer, France – France

<sup>8</sup>MARine Biodiversity Exploitation and Conservation – Institut de Recherche pour le Développement, Institut français de Recherche pour l’Exploitation de la Mer, Centre National de la Recherche Scientifique, Université de Montpellier – France

## Abstract

Global change (climatic and other anthropogenic pressures) leads to episodes of mass mortalities of invertebrates living on hard substrates. These events occur between 0-50 m depths in tropical and temperate regions, with observed mortality decreasing with depth (Garrabou et al. 2009, Hughes et al. 2018). While knowledge of shallow populations of marine invertebrates has largely expanded in recent decades, the study of their genetic diversity in deeper areas (50-150 m) and their connectivity (gene flow) with shallower populations is a burgeoning topic. In particular, interest is now focused on the potential role of deep areas as refuges allowing the spontaneous (re-)colonization of degraded shallow areas (Bongaerts et al. 2010, Rocha et al. 2018). Studies attempting to understand the acclimation abilities of corals and gorgonians in the context of climate change via reciprocal transplantation experiments have recently appeared in the Mediterranean. These notions of connectivity, acclimation and critical habitats are notably a founding theme of the Marine Strategy Framework Directive (MSFD). The refuge hypothesis has been mainly studied in tropical

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\*Speaker

regions, as well as for some coralligenous species in the Mediterranean (Ledoux et al. 2015, Constantini and Abbiati 2016). Furthermore, it has been highlighted the interest within the Mediterranean system to consider the effect of the local environment and the associated ecological niche, on population and community diversity (Cahill et al. 2017). In particular, it is necessary to complete the monitoring of environmental parameters in the coastal area using fixed equipment (i.e. microhabitat monitoring). Moreover, the actual role of deep-sea areas as refuges for these Mediterranean species remains to be tested. In this context, it is necessary to set up long-term monitoring of the abiotic and biotic parameters of these mesophotic habitats. Monitoring coralligenous ecosystems requires the immersion of divers. Due to the material and technical limits allowing access to important depths and to those imposed by the previous French regulations, the scientific monitoring mainly focused on the 0-50 m zone. The evolution of diving techniques, followed by the professional regulations (authorized to 100 m with closed-circuit rebreather (CCR) since 2019 in France) now allow access to these depths (Hocdé et al. 2017). Long-term monitoring of animal populations, local environmental parameters and sampling is therefore possible (Muff et al. 2022). Nevertheless, it requires significant human, logistical, and financial resources, which still largely limit their spatio-temporal scope. During the last decade, recreational deep diving has become more accessible and democratized. As citizens' sensitivity to the environment is growing, the development of citizen sciences (CS) in relation to biodiversity issues is booming (Chandler et al. 2017). In the marine environment, CS have been introduced in the practice of recreational scuba diving within the 0-40 m area (POLARIS, Observadores del Mar). Although extending CS to the deep area remains a promising perspective for long-term monitoring, it requires continuing active support from the scientific community. In such a context, the DEEP projects (DEEP HEART, DEEP EVO, DEEP AI) are at the crossroads of this synergy and contribute to study the effect of environmental variability on the genetic connectivity and acclimatation of Mediterranean gorgonians, keystone species of coralligenous habitats.

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# Methodology for estimating environmental impact of Offshore Windparks on benthic ecosystems – EIA study from NE Baltic Sea

Georg Martin<sup>\*1</sup>, Martin Teeveer<sup>1</sup>, Keili Saava<sup>1</sup>, Hanna-Eliisa Luts<sup>1</sup>, Greta Reisalu<sup>1</sup>, and Kristjan Herkül<sup>1</sup>

<sup>1</sup>Estonian Marine Institute – Estonia

## Abstract

Continuous climatic and energy crisis leads to exploring for new sources of renewable energy globally. Developing of offshore wind energy production seems to be an easy way to fulfil political goals and growing demand in all coastal states around the Baltic Sea. While no offshore wind facilities are in operation currently in the northern Baltic, active development is undergoing and several thousands of km<sup>2</sup> are in the planning process for production of offshore wind energy.

Unfortunately, most favourable sea areas for offshore wind energy development overlap with distribution of shallow, hardbottom habitats supporting highest level of biodiversity in the Baltic Sea ecosystem. So the tremendous impact on these ecosystems is expected while no experiences of comparable scale projects exist from this unique sea area (low salinity and temperature, ice conditions, generally low number of species etc.).

In Estonian coastal sea area at least five offshore wind energy projects (covering more than 1500 km<sup>2</sup>) are under different stages of planning and EIA studies are currently carried out. As we lack experiences of such large-scale construction projects in this part of the Baltic Sea we had to develop methodology for quantifying the nature values and assessing the possible impact of construction on benthos. The developed approach combines survey data of different sources including acoustic measurements, quantitative sampling using SCUBA diving, grab sampling as well as qualitative sampling by ROV and simpler "drop" UW cameras.

Loss and disturbance of the benthic habitats and biological communities have been modelled using GIS tools including machine learning algorithms giving valuable input to the EIA process and further technical planning and site selection for placement of wind turbines and needed supporting infrastructure.

In the paper we present methodology developed for mapping and evaluating the possible effects of windfarm construction project on benthic communities based on combining diving-based sampling with other sources of data and illustrate results of two completed EIA studies.

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# Integrating Diver Propulsion Vehicles (DPVs) with Structure from Motion photogrammetry: a low-cost tool for effective reconstruction of the underwater environments

Daniele Ventura\*<sup>1</sup>

<sup>1</sup>Department of Environmental Biology, Sapienza University of Rome – Italy

## Abstract

Over the past decade, image-based underwater 3D reconstruction has been adopted as a critical tool for 3D recording, mapping, and modelling of submerged features, widely employed in the most diverse fields of sciences such as archaeology, engineering, marine geology, and ecology. In such contexts, it represents an effective tool for the research, documentation, monitoring and, more recently, the public diffusion and awareness of underwater environments. Structure from Motion (SfM) photogrammetry provides an efficient, non-destructive measurement method in environments with limited accessibility, such as underwater habitats. With the growing use of consumer-grade cameras, its application is becoming more accessible, thus benefiting a wide variety of disciplines. Depending on the research needs, it can provide 3D relief and valuable visual information that serve for assessing the preservation of natural resources. In fact, current underwater visual techniques aimed at estimating the abundance, size, or length of marine organisms among shallow-water environments are frequently carried out directly by marine biologists using self-contained underwater breathing apparatus (SCUBA) diving. Such direct visual sampling techniques are considered the most effective method to assess the structure of benthic communities, however, even if they can provide valuable data for ecological studies, there is the potential for non-repeatability and observer bias; furthermore, the collection of accurate and precise visual estimates requires a significant amount of additional bottom time that is often incompatible with safety protocols (also, scientific divers must adhere to safety curve for no-decompression dives profile). These problems are particularly serious in monitoring subtidal temperate hard-bottom marine communities, which present large habitat heterogeneity. Indeed, we have developed a very effective method to map shallow marine areas by using SCUBA divers, aided by Diver Propulsion Vehicles (DPVs) and a low-cost action camera for acquiring HD overlapping images of the seabed suitable for SfM processing. The photographic data were acquired with a GoPro Hero 9 capable of shooting high quality (20 Mpix images) photos with a specific time-lapse function. To perform the acquisition over a large area (3200 m<sup>2</sup> ranging from 23 up to 10 m depth) the camera was mounted on a DPV (Seux X-Joy 7) which allowed the SCUBA diver to map the entire area in only 1h and 10'. Subsequently, by using a Structure from Motion photogrammetric workflow implemented in Agisoft Metashape software, we produced high spatial resolution 2D raster maps and 3D outputs such as dense points clouds and textured meshes of an underwater site. This data, other than providing an exceptional tool for analyzing the benthic habitats from a biological point of view, might also provide a

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\*Speaker

new way to visualize and share the perception of such underwater shallow environments to a large plethora of users, increasing the public awareness and promoting new action for the conservation of underwater habitats.

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# Estimating benthic biogeochemical fluxes in mangrove ecosystems: a challenge when using apnea in the Sinnamary estuary, French Guiana

G rard Thouzeau<sup>\*1</sup>, Emma Michaud<sup>1</sup>, Robert C. Aller<sup>2</sup>, Samuel Dejoie<sup>1</sup>, Raghav Ray<sup>1</sup>, Swanne Gontharet<sup>3</sup>, Jacques Clavier<sup>1</sup>, Isabelle Bihannic<sup>1</sup>, Thierry Lebec<sup>1</sup>, Manon Legoff<sup>1</sup>, Emilie Grossteffan<sup>1</sup>, Arthur Alt<sup>1</sup>, Adeline Bidault<sup>1</sup>, and Joseph Printemps<sup>4</sup>

<sup>1</sup>Laboratoire des Sciences de l'Environnement Marin (LEMAR) – Institut de Recherche pour le D veloppement : UMR6539, Institut franais de Recherche pour l'Exploitation de la Mer : UMR6539, Universit  de Brest : UMR6539, Institut Universitaire Europ en de la Mer, Centre National de la Recherche Scientifique : UMR6539 – France

<sup>2</sup>School of Marine and Atmospheric Sciences [Stony Brook] – United States

<sup>3</sup>Laboratoire d'Oc anologie et de G osciences (LOG) - UMR 8187 – Institut National des Sciences de l'Univers : UMR8187, Universit  de Lille : UMR8187, Universit  du Littoral C te d'Opale : UMR8187, Centre National de la Recherche Scientifique : UMR8187 – France

<sup>4</sup>Soci t  Monsieur Joseph Printemps – Soci t  Monsieur Joseph Printemps, Village indon sien AE 6, 97315 Sinnamary, Guyane franaise – France

## Abstract

Benthic biogeochemical fluxes were measured on bare sediment (BS), pioneer (PM) young (YM) and adult (AM) mangroves with benthic chambers in the dry and/or wet seasons. Measurements were performed at high tide (water-sediment interface, WSI) using apnea, and at low tide (air-sediment interface, ASI) during spring tides. Potential net community production and respiration were measured. During the dry season, benthic CO<sub>2</sub> fluxes highlighted net daytime production and night-time respiration at low tide, both increasing with mangrove age. Similar trends with mangrove growth were observed for sediment Chl *a* biomass and Chl *a*:Pheo ratio. CO<sub>2</sub> flux dynamics at the ASI was strongly linked to photosynthetic activity of the biofilm. CO<sub>2</sub> uptakes during daylight exceed those found in the literature emphasizing the role played by the biofilm on carbon exchanges in young mangroves. The 'dark' CO<sub>2</sub> release (sum of all aerobic/anaerobic respiration processes) provided an estimate of total decomposition in sediment, in the range of the global releases of CO<sub>2</sub> from mangrove sediments in the dark. Net DIC uptake at the WSI was measured during the dry season during daytime with minimum and maximum values in YM and PM, respectively. Daytime DO fluxes at the WSI were also negative, except for AM, highlighting sediment hypoxia and net DO consumption due to respiration and microbial remineralization processes in early stages. Low COP:NOP ratios in overlying water at high tide indicated fresh, labile organic matter and intense remineralization. Bottom-water DO saturation decreased with the rising tide at BS and PM. Minimum value at PM was associated with peaks in water temperature and turbidity at high tide due to mud bank flooding by marine water. Such a trend was less pronounced at YM due to lower particle load in flooding water at the end of the rising tide.

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\*Speaker



During night-time, net DIC release was measured at BS and PM versus net DIC uptake at YM. The latter would result from diffusion and dissolution processes driven by soil pH or from chemoautotrophic organisms. CID fluxes are driven by the combination of different C pools through photosynthesis, chemosynthesis, carbonate precipitation/dissolution, and respiration. Surprisingly, DO release was recorded at night on PM while DO uptakes were higher during the night on BS and YM compared to daylight. Chl *a* biomass in sediment at high tide followed the same distribution pattern as that at low tide. Maximum Chl-*a* biomass was associated with night-time DO release at PM. Only daylight incubations at the ASI were carried out during the wet season. The CO<sub>2</sub> fluxes at low tide highlight overall CO<sub>2</sub> uptake in the vegetated sediments, but net respiration at BS. The impact of rainfalls and biofilm diversity and biomass on CO<sub>2</sub> uptake was shown. As for the dry season, the CO<sub>2</sub> flux variations between facies during the wet season were also linked to sediment Chl *a* biomass and Chl *a*:Pheo ratio. Partitioning of the role played by the different aerobic and anaerobic biogeochemical processes in C fluxes is discussed. The influence of fauna burrowing activity on C dynamics is emphasized.

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# Management of invasive aquatic plants: effectiveness and environmental impact of different methods of mechanical control

Mateusz Draga\*<sup>1</sup> and Maciej Gabka<sup>1</sup>

<sup>1</sup>Department of Hydrobiology, Faculty of Biology, Adam Mickiewicz University in Poznan – Poland

## Abstract

Invasive aquatic species pose one of the most serious threats to the biodiversity of freshwater ecosystems and control of their further expansion became an important issue in the past few decades. The best methods of invasive species management depends on the good knowledge of biology and ecology of such species and aim to be harmless to native ecosystems. Unfortunately, the morphology and behavior of invasive species often changes in their introduced range which makes picking the right control method for target species even more difficult. We believe that the scuba diving can greatly aid our struggle against underwater invasive species for it offers both better insight into aquatic ecosystems and allows the diver to carry out complex tasks underwater.

In year 2020 we started monitoring the population of two invasive aquatic plants (*Elodea nuttallii* and *Cabomba caroliniana*) in Poland. Next, based on these observations and literature studies we picked three methods of mechanical control for testing (hand picking, shading with benthic barriers and using suction dredge). Team of scuba divers was involved in the execution of each of them. Methods were tested during the summer of 2021 in more than dozen different locations all around the Poland. Samples of plants and water were collected and underwater scientific surveys were performed before and after the treatments to evaluate the impact of methods on the invasive plants.

All methods seemed to achieve their goal and reduced significantly the biomass of invasive plants in studied areas. The effects of hand picking and shading with benthic barriers turned out to be particularly interesting. The first one mitigated the damage amongst native flora and the second resulted in almost total eradication of treated invasive plants. Interestingly, in some instances just a few weeks after the treatments native species of underwater plants began to recolonize the area previously claimed by invasive plants. However, further studies are necessary to evaluate the long-term effect of each method.

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\*Speaker

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# Towards a better understanding of the ecology of *Hemimysis anomala*, an invasive alien small pelagic crustacean, in Lake Geneva

Stéphan Jacquet<sup>\*1</sup>, Hervé Rogissart<sup>2</sup>, Jean Guillard<sup>1</sup>, Clément Rautureau<sup>1</sup>, Jonathan Grimond<sup>3</sup>, and Victor Frossard<sup>4</sup>

<sup>1</sup>CARRETEL – Institut national de recherche pour l’agriculture, l’alimentation et l’environnement (INRAE) – France

<sup>2</sup>CARRETEL – Institut national de recherche pour l’agriculture, l’alimentation et l’environnement (INRAE) – France

<sup>3</sup>Subbear Studies – Subbear – France

<sup>4</sup>CARRETEL – Université Savoie Mont Blanc – France

## Abstract

The bloody-red shrimp (*Hemimysis anomala*) is an invasive crustacean belonging to the Mysidae family and native to the Ponto-Caspian region (Eastern Europe). This animal has recently settled in some peri-alpine lakes, among which the largest natural deep ecosystem in occidental Europe, e.g. Lake Geneva. The proliferation of this species can have a variety of impacts on both native species and the functioning of lake ecosystems, while considering its planktonophagous diet, in one hand, and because it constitutes a potential prey for fish, in another hand. Due to its nocturnal activity, as individuals hide during the day in interstitial spaces (e.g. cavities, under stones, wrecks, etc...), the assessment of its abundance and *in-situ* behavior remains difficult to obtain with traditional sampling methods. Scuba diving helped us to (i) detect and follow the animal in a variety of locations and habitats, (ii) make pictures and videos, (iii) sample animals with a designed and dedicated sampler for delayed molecular analysis, (iv) instrument a site with high-resolution acoustic and visible/infrared cameras. This talk is the opportunity to present a variety of results dealing with the habitat, abundance, dynamics, swarm behavior and biotic interactions of the bloody-red shrimp.

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\*Speaker

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# Application of survey methods to investigate the relationship between factors influencing the sight-aesthetic attractiveness of underwater lake landscapes.

Anna Żrobek-Sokolnik\*<sup>1</sup>, Piotr Dynowski\*<sup>1</sup>, Adam Senetra<sup>1</sup>, and Marta Czaplicka<sup>1</sup>

<sup>1</sup>University of Warmia and Mazury [Olsztyn] – Poland

## Abstract

Research undertaken to date has covered issues related to the assessment of landscapes and seascapes. This paper addresses issues of assessing the sight-aesthetic values of underwater landscapes of inland water bodies. The results of a survey conducted on a sample of 200 divers using the direct comparison method are presented. Surveys were conducted for five main groups of factors: bottom shape, submerged anthropogenic objects, natural obstacles, vegetation and animals. The type and strength of relationships between factors affecting the attractiveness of underwater landscapes were determined. In addition, a relevance hierarchy of groups and individual landscape elements was developed.

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\*Speaker

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# Impact of gold mining activities on the ascidian *Polycarpa aurata* in the North Sulawesi, Indonesia

Massimo Ponti\*<sup>1,2</sup>, Eva Turicchia<sup>1,2</sup>, Riccardo Ercadi<sup>1</sup>, Marco Tamburini<sup>3</sup>, Greta Zampa<sup>1</sup>, Denis Badocco<sup>4</sup>, Fabio Gasparini<sup>4</sup>, Roberta Guerra<sup>1</sup>, Lorian Ballarin<sup>4</sup>, Daisy Makapedua<sup>5</sup>, Jane Mamuja<sup>5</sup>, Markus Lasut<sup>5</sup>, and Paolo Pastore<sup>4</sup>

<sup>1</sup>University of Bologna – Italy

<sup>2</sup>Reef Check Italia Onlus – Italy

<sup>3</sup>University of Pavia – Italy

<sup>4</sup>University of Padua – Italy

<sup>5</sup>Sam Ratulangi University [Manado] – Indonesia

## Abstract

Coral reefs are increasingly threatened by multiple stressors, both natural and anthropogenic. These include the pollution from potentially toxic trace elements that can accumulate in marine and coastal environments, deriving from natural processes, including rock weathering, volcanic emissions, and aeolian transport, but also a number of human activities. Swift industrialization, economic development, and urbanization contributed to an increase of trace elements in seas, above all in estuarine and coastal habitats. This growing spread of trace elements and other pollutants from anthropogenic activities threatens local species and humans and has assumed global relevance. For instance, traditional and modern gold mining activities are underway in North Sulawesi, Indonesia, some of which have been around for a long time. Depending on the methods employed in gold mining and the local rocks mineralogy, potentially toxic trace elements can be released in the drainage basin and thus reach the coastal environments. Artisanal and small-scale gold mines (ASGMs) have been accompanied by widespread usage of mercury, putting Indonesia among the top three global emitters of this pollutant, and posing potential risks to the marine ecosystem and human health. Although the use of mercury has been largely eliminated, following the Minamata Convention, the mercury amalgamation practice in ASGM has persisted in several Indo-Pacific regions, including the North Sulawesi. Many regions often underestimate this practice and related problems, especially where ASGMs are allowed or tolerated without adequate environmental standards. The contamination of mercury and other potentially toxic trace elements coming from both industrial mines and ASGMs in marine suspended particulate matter and their bioaccumulation in two tissues (tunic and body devoid of tunic) of the ascidian *Polycarpa aurata* was assessed, comparing samples collected downstream of four mines and at four control sites in the North Sulawesi. Environment contamination and bioaccumulation varied according to the mining process, mining age, considered environmental matrix and target species, however in some cases levels resulted very high, posing risks not only for the environment but also for human health. Indonesia is regarded as one of the richest areas of our planet in mineral deposits, especially auriferous veins, and the number of mines is constantly increasing. To reduce their impact and possible long-term consequences

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\*Speaker

on coastal habitats and human well-being, it is necessary to phase out mercury amalgamation for gold extraction, regulating artisanal mining, and enforcing environmental regulations and regular monitoring must be a priority objective for many countries, especially Indonesia.

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# Underwater photogrammetry combined with different environmental data

Sebastian Pose\*<sup>1</sup>, Thomas Grab<sup>1</sup>, and Tobias Fieback<sup>1</sup>

<sup>1</sup>TU Bergakademie Freiberg, Scientific Diving Center – Germany

## Abstract

The use of photogrammetry is increasing in all areas of research. Even in underwater investigations, the requirements are constantly increasing and so are the data volumes, e.g. to improve the quality of the images. Data from a variety of different sources are increasingly being used. At the Scientific Diving Center of the TU Bergakademie Freiberg, for example, aerial drones are used to record the current surface conditions. In addition, a swimming robot from the RoBiMo project (<https://tu-freiberg.de/robimo>), which was also developed at the TU Freiberg, is used with a multi-frequency multibeam echo sounder to record the subsurface conditions of the underwater investigation. Detailed images of selected underwater objects (cultural heritage, mechanical components, biological abiotic objects, etc.) are additionally recorded by scientific divers using photogrammetry. In order to merge the data, it is essential to integrate them into a uniform data structure. In the talk, experiences with concrete examples are presented and challenges are explained. To optimize the image quality, different program settings for underwater and above water were investigated and quantified by means of mathematical evaluation. In addition, the use of video data as an image source for photogrammetry was investigated and a selection of application criteria as well as the influence on the quality of the calculated model was created. These results and an approach to combine data from different sources into a unified model as well as problems and challenges in combining them are discussed.

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\*Speaker

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# Using novel methodologies to monitor shallow water coral communities and investigate structural complexity

Louis Hadjioannou<sup>\*1</sup>, Felix Pedrotti<sup>2</sup>, Manos L. Moraitis<sup>1</sup>, and Neophytos Agrotis<sup>1</sup>

<sup>1</sup>Cyprus Marine and Maritime Institute – Cyprus

<sup>2</sup>University of Southampton – United Kingdom

## Abstract

Populations of the shallow water coral *Cladocora caespitosa*, a Mediterranean endemic and endangered species, have been characterized in many locations, mostly using traditional visual census techniques. These techniques have also been used to evaluate and compare the distribution, abundance and condition of colonies at two sites in Cyprus as well as for continuous long-term monitoring. However, the methods used fail to accurately quantify the diversity of morphologies observed within the species while also being costly, time-consuming and of uncertain accuracy.

In this study, we investigate the use of novel methodologies/optical techniques/remote sensing techniques (i.e., photogrammetry) to map populations, measure and visualize the 3D structural complexity of *C. caespitosa* colonies, using scientific diving at different spatial and temporal scales, more efficiently and at an increased accuracy.

Research on *C. caespitosa* from past decades has shown that it is threatened by increasing disturbances affecting coastal ecosystems, such as climate change (e.g., extreme storms, elevated seawater temperatures), invasive species, and outbreaks of corallivorous species. Being an endangered species that has the potential of building large bioconstructions that can support high biodiversity, continuous and systematic monitoring in as much accuracy as possible should be conducted in order to identify the long-term effects of these threats. The ability to accurately quantify changes in the structural complexity of important, habitat-building species is vital to understanding and potentially restoring ecosystem functions. The results will be contributing to existing knowledge that aim to identify long-term solutions and design conservation strategies.

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<sup>\*</sup>Speaker



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# Underwater procedures for long-term photographic monitoring of benthic biocoenosis in shallow hard bottoms – a perspective from the high-Arctic

Bernabé Moreno<sup>\*1</sup>, Piotr Balazy<sup>1</sup>, Maciej Chelchowski<sup>1</sup>, Marta Ronowicz<sup>1</sup>, Anna Sowa<sup>1</sup>, and Piotr Kuklinski<sup>1</sup>

<sup>1</sup>Marine Ecology Department, Institute of Oceanology Polish Academy of Sciences – Poland

## Abstract

Open-circuit scientific diving is a rigorous cost-effective research tool widely used for studying benthic biocoenoses in shallow sublittoral zones. Long-term experiments can gather relevant baseline ecological information as well as trace ongoing environmental changes, while optical imagery is increasingly being used to acquire, process, share, and reuse data, ultimately building valuable archives. However, standardised procedures are needed to increase interoperability and enable objective comparison between observations of ecological processes in different marine ecoregions. Here, we present results and procedures recommendations based on a long-term experiment (18 yr) using artificial settlement plates to study different aspects of benthic ecology in Isfjorden; a 78°N high-Arctic fjord subjected to strong environmental gradients. Investigated development processes include first-year early colonisation and multiannual succession of sessile invertebrates and coralline algae assemblages. The experimental setup consisted of a 4x3-array of plates facing upwards and a parallel array facing downwards, framed within a metal construction secured to the seabed using ballast rocks (Kuklinski et al. 2022). Overall, a total of six constructions were placed over the hard-bottom at three-stations (S1, S2 and N1), two-depths each (8 m infralittoral, and 14±1m circalittoral). The first deployment (S1,2) occurred in 2004, yet the main experiment is still running. Experiment subsets were deployed at N1 and S2 to assess the effect of seasonally different starting-points on the assemblage development throughout 2016–17. Long-term monitoring stations were defined by a fixed downslope transect-line perpendicular to the coastline and an underwater buoy. Diving procedures included i) marking the diving site, ii) locating the deep constructions and marking them with diving strobes, iii) alternately photosampling, overturning and ultimately ballasting the circalittoral and infralittoral constructions, taking over one hour underwater, on average. Multiple overlapping high-resolution macro-photographs per plate were obtained using a 36MP full-frame camera sensor, a 60mm f/2.8 macro lens, and two high-power wide-beam strobe lights. Fluctuations of light intensity and turbidity due to suspended particulate material and density gradients required readjusting strobe-light positioning, but to avoid backscattering, an indirect angle was used to light-up the object. This was achieved by placing the strobes from behind the camera so that only the edges of the light-beams reached the plate surface. Good-performance camera settings were obtained by combining between the spectrum of  $f$ -stop  $\geq 16$ ; shutter speed faster than 1/100 s, but slower than 1/250 s (max. strobe sync-speed); and ISO 100–300. A more efficient standardisation is achievable by using a 'sliding frame' or similar fixed rig to ensure a constant distance

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\*Speaker

between the sensor and the plate. Considering a minimum of two person-dives per station to cover the photosampling and panel recovery, an estimate of 88 separate person-dives and over one hundred logged hours of diving time were safely completed in conditions ranging between 8 and -1 °C of water temperature during summer and polar night, respectively. This work provides a replicable and sustainable underwater procedure that is adapted to unfavourable and challenging conditions but can be safely used globally for long-term photographic monitoring of benthic assemblages. References:

Kuklinski P, Balazy P, Porter J, Loxton J, Ronowicz M, Sokolowski A (2022) Experimental apparatus for investigating colonization, succession and related processes of rocky bottom epifauna. *Continental Shelf Research*; 233:104641.

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# Unveiling hidden seascapes: SfM-photogrammetry, a powerful tool for marine caves monitoring

Torcuato Pulido Mantas<sup>\*1</sup>, Barbara Calcinai<sup>1</sup>, Martina Coppari<sup>1</sup>, Cristina Gioia Di Camillo<sup>1</sup>, Teo Marrocco<sup>1</sup>, Stefania Puce<sup>1</sup>, Camilla Roveta<sup>1</sup>, and Carlo Cerrano<sup>1,2,3</sup>

<sup>1</sup>Polytechnic University of Marche [Ancona, Italy] / Università Politecnica delle Marche [Ancona, Italia] – Italy

<sup>2</sup>Stazione Zoologica Anton Dohrn, Dept. of Integrative Marine Ecology – Italy

<sup>3</sup>Fano Marine Center, Viale Adriatico 1/N, 61032 Fano, Italy – Italy

## Abstract

Despite the small fraction of marine environment represented by marine caves, they are considered biodiversity hotspots that host a wide variety of sciaphilous communities, acting as a reservoir for many endemic species. Although their geology, biology and ecology have been studied for several decades now; only recently, the need to evaluate their health status and threats has been emphasized. Traditionally, monitoring approaches to survey marine caves have been constrained by equipment limitations and strict safety protocols. Nowadays, the rise of new approaches opens new possibilities to describe these peculiar ecosystems. Structure from Motion (SfM) photogrammetry is one of these approaches that allows to obtain a detailed 3D digital reconstruction from a series of overlapping images. In recent years, this technique called the underwater research field attention due its non-destructive character, versatility, and relatively rapid survey of the sessile community. In this context, the current study aimed to explore the potential of SfM-photogrammetry to assess the abundance and spatial distribution of the sessile benthic assemblages inside a semi-submerged marine cave. The results of SfM were compared with a more "traditional approach", by simulating photo-quadrats deployments over the produced orthomosaics. Not all individuals were immediately recognised in the orthomosaic though; in order to identify individuals at the lowest taxonomical level possible, samples were collected and processed for taxonomical analysis. A total of 22 sessile taxa were identified, with Porifera representing the dominant taxa within the cave. SfM and photo-quadrats obtained comparable results regarding species richness, percentage cover of identified taxa and most of seascape metrics, while, in terms of taxa density estimations, photo-quadrats highly overestimated their values. SfM resulted a suitable non-invasive technique to record marine cave assemblages, and seascape indexes proved to be a comprehensive way to describe the spatial pattern of distribution of benthic organisms, establishing a useful baseline to assess future community shifts.

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\*Speaker

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# Local habitat characteristic structuring benthic community in circalittoral temperate rocky reefs, a photogrammetric based approach

Quentin Ternon<sup>\*1,2</sup>, Frédéric Ysnel<sup>3</sup>, Antoine Collin<sup>4</sup>, Eric Feunteun<sup>2,5,6</sup>, Valentin Danet<sup>1</sup>, Olivier Bianchimani<sup>7</sup>, and Pierre Thiriet<sup>8</sup>

<sup>1</sup>Museum National d'Histoire Naturelle (MNHN), Station Marine de Dinard, Centre de Recherche et d'Enseignement sur les Systèmes CÔtiers (CRESCO), 35800 Dinard, France – Muséum National d'Histoire Naturelle (MNHN) – France

<sup>2</sup>Laboratoire Biologie des Organismes et Écosystèmes Aquatiques, (MNHN, CNRS 8067, SU, IRD 207, UCN, UA), 75231 Paris Cedex, France – Laboratoire BOREA – France

<sup>3</sup>Université de Rennes, Laboratoire BOREA (MNHN, CNRS 8067, SU, IRD 207, UCN, UA), 35042 Rennes Cedex, France – Université de Rennes 1 – France

<sup>4</sup>EPHE - PSL, Centre de Géo-Ecologie Littorale (CGEL), 35800 Dinard, France – École Pratique des Hautes Études [EPHE] – France

<sup>5</sup>Museum National d'Histoire Naturelle (MNHN), Station Marine de Dinard, Centre de Recherche et d'Enseignement sur les Systèmes CÔtiers (CRESCO), 35800 Dinard, France – Muséum National d'Histoire Naturelle (MNHN) – France

<sup>6</sup>EPHE - PSL, Centre de Géo-Ecologie Littorale (CGEL), 35800 Dinard, France – École Pratique des Hautes Études [EPHE] – France

<sup>7</sup>Septentrion Environnement, 13007 Marseille, France – Septentrion Environnement – France

<sup>8</sup>UAR Patrimoine Naturel, OFB, CNRS, MNHN, CRESCO, 35800 Dinard, France – PATRINAT – France

## Abstract

The way benthic communities are linked to marine rocky habitat characteristics still remains poorly documented. In the past decade, photogrammetry has been developed in submarine environments and has allowed to produce high resolution information on hard substrate characteristics. The aim of this study was to unravel the multi-scale processes involved in the structuration of biocenosis by the habitat characteristics. A photogrammetric methodology is developed to describe both the biotope (geomorphological variables and substrate composition mapping) and the associated benthic community along 120 m<sup>2</sup> transects. This methodology couples a supervised classification process to describe the biotope and photo-quadrat to characterize morphotype diversity of the benthic community using a morphotypic approach (based on the CATAMI classification). This study was conducted in three rocky reefs of the St Malo bay (~ 250 km<sup>2</sup>) in Brittany (France) along a coast to offshore gradient. The methodology developed exhibits a well completeness (more than 70% of the maximum morphotypic richness) and estimate of the proportion of the morphotypes identified (less than 10% of error). The results confirmed the importance of the broad scale

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\*Speaker

(> 120 m<sup>2</sup>) environment on the control of benthic communities with up to 24% of the variance explained by inter-site and inter-depth variability. Interestingly, the metrics produced by photogrammetry revealed that the composition of the benthos is also shaped by fine scale (< 120 m<sup>2</sup>) habitat characteristics. Geomorphology and substrate composition described at 0.09 and 120 m<sup>2</sup> explained up to 18% and 37% of the structuring of benthic communities respectively. The description of substrate typological patches, especially bedrock, small boulders and pebble, as well as geomorphological descriptors, more particularly curvature, aspect and depth range, were underlined to structure benthic community composition. This study brings tools to characterize and predict benthic communities' characteristics from multi-scale habitat descriptions in temperate rocky reefs.

## **Underwater investigation on macro-zoobenthic richness of a dam system in the harbour of Trieste (northern Adriatic Sea): a 6 year study**

Lisa Faresi<sup>1</sup>, Nicola Bettoso<sup>1</sup>, Ida Floriana Aleffi<sup>1</sup>, Francesco Cumani<sup>1</sup>, Claudia Orlandi<sup>1</sup>

<sup>1</sup>ARPA FVG-Regional Agency for the Environmental Protection of Friuli Venezia Giulia Region, via Cairoli 14, 33057, Palmanova (UD), Italy

The richness of the macrozoobenthos community settled on the concrete vertical wall of the dam system protecting the industrial harbour of Trieste is investigated since 2017, following the monitoring program on the basis of Marine Strategy Framework Directive (MSFD, 2008/56/EC). The sampling was performed thank to SCUBA diving by means of the scraping techniques on a 30x30 cm quadrat. The middle area in the inner side of the longest dam (about one terrestrial mile) was chosen as sampling site. Three station were selected, each one far 15 meters, and at -2 and -5 meters depth. In addition a Canon PowerShot G10 equipped with SEA&SEA YS110 $\alpha$  strobe was employed to get images on every quadrat before and after the removal of benthic organisms. During the 6 years (2017-2022) the monitoring was performed twice a year (Spring/Summer and Autumn) and a total of 72 quadrat were sampled and analyzed. Organisms were preserved at -20° C before sorting and identification at the lowest possible taxon.

259 species were identified from 10 phyla of which 212 species at -2 m and 219 at -5 respectively. Mollusca, Annelida, Arthropoda and Porifera were the most represented phyla in term of species richness followed by Chordata, Echinodermata, Sipunculida, Bryozoa. Cnidaria and Platyhelminythes. The lowest number of species was recorded in September 2019 (84 species), whereas the highest in October 2022 with 109 species. No significant differences were detected among years and depth.

Despite the study area is located in an industrial port, the macrozoobenthos community seems quite diversified, with richness values comparable to those of community settled on natural substrata.



# List of Posters



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# Polish Committee on Scientific Diving established (poster)

Piotr Balazy\*<sup>1</sup>, Bartosz Kontny<sup>2</sup>, Dariusz Puczko<sup>3</sup>, Andrzej Pydyn<sup>4</sup>, Janusz Różycki<sup>5</sup>,  
and Michał Saniewski<sup>6</sup>

<sup>1</sup>IO PAN – Poland

<sup>2</sup>WA UW – Poland

<sup>3</sup>IBB PAN – Poland

<sup>4</sup>CAP UMK – Poland

<sup>5</sup>NMM – Poland

<sup>6</sup>IMGW PiB – Poland

## Abstract

Scientific diving in Poland, i.e. diving for research purposes, is recognized by law and referred to in art. 1. paragraph 3 points 3 of the Act of 17 October 2003 on underwater works (i.e. OJ of 2014, item 1398, as amended) since 2014. Until recently however, this form of underwater activity was not subjected to any specific regulations. A number of informal meetings were held in order to change this state of affairs. Among others, in April 2019, on the last day of the 5th European Conference on Scientific Diving in Sopot, the first meeting of this kind in Poland devoted to gathering a broad group of international specialists as well as to consolidate the Polish scientific diving community, consultations between the European Scientific Diving Panel representatives and diving scientists from Poland took place. An initiative group created at that time, and later on, consisting of several research institutions and museums dealing with science underwater (i.e. Institute of Oceanology Polish Academy of Sciences – IO PAN, Faculty of Archaeology, University of Warsaw - WA UW, Institute of Meteorology and Water Management, National Research Institute – IMGW PIB, National Maritime Museum – NMM, Institute of Biochemistry and Biophysics, Polish Academy of Sciences – IBB PAN, Centre for Underwater Archaeology, Nicolaus Copernicus University in Toruń – CAP UMK) brought to life the "Polish Committee on Scientific Diving" ("Polski Komitet Nurkowania Naukowego – PKNN" *in Polish*). Its aim is to further unite Polish institutions involved in diving for research and scientific purposes, organized by Polish universities, scientific and research institutes, museums (referred to as scientific diving), to represent the interests of the Parties both on the national and international arena, cooperation and exchange of experiences, adoption and development of appropriate standards and procedures, including future introduction of regulations regulating fully scientific diving in Poland, as well as supporting the development of this field of underwater research in Poland. We kindly invite all institutions from Poland to cooperate in order to fulfil the proposed aims together.

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\*Speaker



# Quantification of ecosystem functioning and services provided by *Mytilus trossulus* from the eastern Baltic Sea

I Barda<sup>1</sup>, A Fedorovska, M Kostanda, L Spilva, A Armoskaite, S Strake, I Andersone

Latvian Institute of Aquatic Ecology, Voleru Str 4, Riga, LV-1007

The Latvian coast of the Baltic Proper can be characterized as one of the most open and exposed shores of the Baltic Sea. In these high energy shores distribution of mussels *Mytilus trossulus* depends highly on the presence of hard bottom substrata (stony reefs) at 7 m till 40 - 60 m depth. These reefs form the multidimensional structure of benthic community and are providing spawning grounds for herring, act as sheltering and nursery places for juvenile fishes and are crucial as feeding areas for waterbirds etc.. Mussels *M. trossulus* is crucial key species of stony reef habitats providing a significant impact of the surrounding ecosystem. For example, their high capacity to filter phytoplankton, detritus, and bacteria from the water, thus accumulating large quantities of nitrogen and phosphorus in their tissues, increases the transparency of the water – an important factor in the supply of multiple ecosystem services. Therefore, due to their high ecological value stony reefs are one of the most significant and protected habitats in the Baltic Sea.

It is well known, that the Baltic Sea ecosystem over years has been impacted by intensive agriculture and wastewater discharge, hazardous substances release and introduction of non-indigenous species with ballast waters. The round goby (*Neogobius melanostomus*) represents a successful invader that has colonized numerous habitats worldwide, including Baltic Sea. Due to its behavior it has become one of the dominant benthic fish species in the Baltic, affecting native organisms and their ecological functions. Video footage of the stony reefs suggests that the Latvian coast of the open Baltic Sea is not an exception - as a dramatic decrease in the *M. trossulus* population can be observed as a result of direct predation of round goby. Therefore, the aim of this study was to quantify ecosystem services (respiration and clearance rates) provided by *M. trossulus*, which will be included in further ecosystem evaluation analysis.

Mussels *M. trossulus* were collected in the Baltic Sea by scuba diving and transported to the laboratory. Experiments were conducted in the 1.5 L tanks with water collected at the sampling site, which was kept at the water temperature measured at the sampling site (+8 °C) (ICES techniques No 40, 2016). Prior the experiment mussels were divided in size classes: 0.5-1 cm; 1-2 cm; 2-3 cm; 3-4 cm and 4-5 cm of shell length. Respiration experiment was conducted for 60 min, measuring oxygen reduction every 10 minutes. The clearance rate (CR) was measured as a decrease of green microalgae (*Desmodesmus subspicatus*) cells for 70 minutes.

Respiration rates of mussels were (RR) correlated with size classes. An increase in respiration rate within the mussel size was detected ( $0,104 \pm 0,01 \text{ mg O}_2 \text{ h}^{-1}$  for 0.5-1 cm and  $0,337 \pm 0,08 \text{ mg O}_2 \text{ h}^{-1}$  for 4-5 cm, respectively). The same tendencies were detected for CR, where the highest rate showed 4-5 cm large mussels ( $1,83 \pm 0,027 \text{ L h}^{-1}$ ).

Research is supported by the project "Research of marine protected habitats in EEZ and determination of necessary conservation status in Latvia " LIFE19 NAT/LV/000973

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<sup>1</sup> Speaker

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# The contribution of the time-lapse technique to behavioural ecology studies

Martina Coppari\*<sup>1</sup>, Teo Marrocco<sup>1</sup>, Torquato Pulido Mantas<sup>1</sup>, Camilla Roveta<sup>1</sup>, Davide De Benedictis<sup>2</sup>, Antonio Lettini<sup>3</sup>, Bruno Schisa<sup>3</sup>, Barbara Calcinai<sup>1</sup>, Cristina Gioia Di Camillo<sup>1</sup>, Stefania Puce<sup>1</sup>, and Carlo Cerrano<sup>1,4,5</sup>

<sup>1</sup>Università Politecnica delle Marche – Italy

<sup>2</sup>Reef Check Italia Onlus – Italy

<sup>3</sup>Stigliano – Italy

<sup>4</sup>Stazione Zoologica Anton Dohrn – Italy

<sup>5</sup>Fano Marine Center – Italy

## Abstract

The study of marine animal's behaviour is of crucial importance to understand their evolution, survival, and reproductive success. Behavioural ecology is the discipline that analyse all these aspects, but its development underwater is particularly challenging.

The visual observation is undoubtedly the most attractive method for this kind of studies, even though it presents some limitations (e.g., the size of the target organism, the disturbance of the observer and a limited time to spend underwater). For a scientific diver, *in-situ* observations of macrobenthic species for periods exceeding the allowed time range, present many technical challenges, with the use of automated time-lapse devices helping to overcome most of these problems.

Contrary to the classical studies in which the community and its structure are investigated by estimating the percentage cover and abundance of macrobenthos, time-lapse photography, that has been used in scientific applications for over 100 years, allows to study and understand several dynamics in different benthic organisms. In addition, the application of motion studies makes possible to analyse the behaviour and the movement of benthic fauna over long time periods, also observing the inactivity and mobility of the organisms.

In the framework of the Coral Hidden Life (CHILI) project, FRANKIE 2.0, an ad-hoc time-lapse equipment for the monitoring of benthic organisms, was developed by the Stigliano enterprise. The time-lapse has a digital GoPro8 camera, currently presenting eight different time configurations, from a minimum of 3 to a maximum of 30 minutes, which can be set by the user before its placement. However, time settings can be adapted and modified by a software configuration. The system has a maximum operative depth of 100 m and, due to its limited size and weight, can be easily transported and positioned by the scuba operator. FRANKIE 2.0 includes an external battery pack (maximum capacity of 70 Ah), characterised by a wet-mate connector, allowing the underwater exchange of the battery, thus extending the recording period. The duration of the battery pack set with a capacity of 50 Ah and with 3 minutes time-lapse was tested in the field corresponding to 288 hours. In addition,

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\*Speaker

the time-lapse unit presents a flexible arm with a customized KX1 light and an underwater base tripod XL, with adjustable arms of 24 cm length.

Different study cases are presented as an example of the application of the time-lapse system FRANKIE 2.0, allowing to describe behavioural and functional aspects of benthic organisms which received little consideration in the scientific literature so far.

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# Factors influencing the attractiveness of underwater lake landscapes in terms of tourist exploration.

Piotr Dynowski\*<sup>1</sup>, Anna Żrobek-Sokolnik\*<sup>1</sup>, Adam Senetra<sup>1</sup>, and Marta Czaplicka<sup>1</sup>

<sup>1</sup>University of Warmia and Mazury [Olsztyn] – Poland

## Abstract

The scenic features of a landscape are one of the most important elements during tourist exploration. They determine its attractiveness and choice by tourists. The development of various forms of diving makes it necessary to identify sites attractive to divers and to channel tourist traffic underwater in order to protect the aquatic environment. The paper focuses on this topic due to the lack of similar studies on inland water bodies. Similarities of features (elements) between terrestrial and underwater environments are shown, and the possibilities of assessing them on the basis of existing research methods used so far on land.

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## **An Innovative *in situ* Method for Assessing Primary Productivity in Benthic Communities on Rocky Shores (poster)**

Reis B <sup>1,2</sup>; Arenas F<sup>1</sup>; Meyer H <sup>1</sup>; Babe O <sup>1</sup>; Linden P <sup>1</sup>; Peiffer F <sup>3</sup>; Sousa-Pinto I <sup>1,2</sup>; Franco JN <sup>4\*1</sup>

<sup>1</sup> *Interdisciplinary Centre of Marine and Environmental Research (CIIMAR), University of Porto, Porto, Portugal;*

<sup>2</sup> *Faculty of Sciences, University of Porto, Portugal ;*

<sup>3</sup> *ISPA – Instituto Universitário, Lisboa*

<sup>4</sup> *MARE-Marine and Environmental Sciences Centre & ARNET—Aquatic Research Network Associated Laboratory, ESTM, Polytechnic of Leiria, 2520-641 Peniche, Portugal*

\* e-mail: [joao.franco@ipleiria.pt](mailto:joao.franco@ipleiria.pt)

Assessing the impact of climate change on nearshore rocky habitats requires an understanding of their ecosystem functioning. Primary productivity is a key measure of this functioning, but accurately quantifying it in turbulent rocky habitats is challenging and information is scarce.

Previous methods for assessing seaweed primary productivity, such as quantifying carbon standing stock and biomass or ex-situ incubations, have limitations in representing real primary productivity and neglecting the community effects on the productivity.

We present a novel methodology for assessing primary productivity of entire benthic communities *in situ* using incubation chambers that simultaneously record oxygen flux, temperature, and photo-synthetically active radiation. Our flexible chambers allowed for wave motion while minimizing water exchange. We applied this methodology in a case study comparing kelp-dominated reefs to turf-dominated reefs along the Portuguese continental coast (37° N, 39° and 41° N). Our results demonstrate that our methodology is feasible for different benthic habitats and provides reliable *in situ* net primary productivity values, confirming higher primary productivity in kelp-dominated reefs compared to turf-dominated reefs per unit of biomass.

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<sup>1</sup> Speaker

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# Natura 2000 marine benthic habitats in Latvian coastal waters: identification and challenges

Anete Fedorovska\*<sup>1</sup>, Ieva Barda<sup>1</sup>, and Ingrida Andersone<sup>1</sup>

<sup>1</sup>Daugavpils University agency Latvian Institute of Aquatic Ecology – Latvia

## Abstract

The Baltic Sea is small sea by its territory but one of the world's largest brackish water-body with very sensitive and changing ecosystem. The Habitats Directive (92/43/EEC) lists nine habitats that requires the designation of special areas of conservation. We considered that in Latvian coastal waters two of these biotopes need more attention and interpretation – "1110 Sandbanks which are slightly covered by sea water all the time" and "1170 Reefs". Expanded definitions are crucial to correctly establish assessment system of hard substrate biotopes and sandbanks quality evaluation.

We have seven marine protected areas in Latvian coastal waters that mostly consist of hard substrate biotopes - reefs and occupy area of 4360 km<sup>2</sup>. Reefs have evident ecological zonation defined by depth and associated with vegetation and animals. However, no territory is assigned special protection status for sandbanks because of the lack of clear definition that would describe the real conditions in Latvian coastal waters. Sandbanks are defined as topographic features that are slightly covered with water not deeper than 20 m and usually associated with macrovegetation. Nevertheless, we have identified such structures from the shoreline to deeper offshore zones with no vegetation that only partly meet the regular definition. Sandbanks can be often found in association with reefs and Latvian interpretation manual of EU biotopes cites that these biotopes should be common in Latvian coastal waters. Often Latvian coastal biotopes are patchy and in local area reefs are mixing with sand banks like structures.

We suppose that due to long term anthropogenic influence on benthic biotopes they frequently do not meet good environmental status and are degraded, furthermore loss of some typical species could occur. Expanded definition of reefs and sandbanks adapted to the situation of Latvian coastal waters has been developed and bottom communities were described in depth range 5-35m.

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\*Speaker

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# Scientific diving in France: an overview of the current practices in science

Régis Hocdé<sup>\*1</sup>, Gérard Thouzeau<sup>2</sup>, Laurent Borel , Mathieu Coulange , Jean-Pierre Féral<sup>3</sup>, Eric Feunteun , Stéphan Jacquet , Philippe Le Bras , Line Le Gall , Sébastien Legrand , Philippe Lenfant<sup>4</sup>, Mario Lepage<sup>5</sup>, Caroline Play , Gilles Saragoni<sup>4</sup>, and Quentin Schull<sup>6,7</sup>

<sup>1</sup>MARBEC, Univ Montpellier, CNRS, Ifremer, IRD, Montpellier, France – MARBEC, Univ Montpellier, IRD, IFREMER, CNRS, Montpellier, France. – France

<sup>2</sup>Laboratoire des Sciences de l'Environnement Marin UMR 6539 (LEMAR) – Institut Universitaire Européen de la Mer (IUEM) – Technopôle Brest Iroise, Rue Dumont d'Urville, 29280 Plouzané, France

<sup>3</sup>Institut Méditerranéen de Biodiversité et d'Ecologie marine et continentale (Marseille) (IMBE) – UMR CNRS 7263 – France

<sup>4</sup>Université de Perpignan Via Domitia, Centre de Formation et de Recherche sur les Environnements Méditerranéens, UMR 5110 CNRS-UPVD-CEFREM – Université de Perpignan Via Domitia, Centre de Formation et de Recherche sur les Environnements Méditerranéens, UMR 5110 CNRS-UPVD-CEFREM – 52 Avenue Paul Alduy, 66860, Perpignan, France

<sup>5</sup>Institut national de recherche en sciences et technologies pour l'environnement et l'agriculture - IRSTEA (FRANCE) (IRSTEA) – Institut national de recherche en sciences et technologies pour l'environnement et l'agriculture - IRSTEA (FRANCE) – 50 avenue de Verdun, 33612 Cestas Gazinet, France

<sup>6</sup>MARine Biodiversity Exploitation and Conservation – Institut de Recherche pour le Développement : UMR<sub>D</sub>248, *Institut français de Recherche pour l'Exploitation de la Mer* : UMR9190, *Université de Montpellier* : UMR9190, *Centre National de la Recherche Scientifique* : UMR9190 – *Centre de Sète UMR MARBEC SETE – Avenue Jean Monnet – CS3017134203 SETE CEDEX, France*

<sup>7</sup>Institut Pluridisciplinaire Hubert Curien – Centre National de la Recherche Scientifique : UMR7178, université de Strasbourg – 23 rue Loess - BP 28 67037 Strasbourg Cedex, France

## Abstract

The French National Committee for Scientific Diving (CNPS) takes on different tasks including acting as an observatory of occupational scientific diving practices and innovations (Thouzeau et al., 2019). Since 1991 in France, scientific diving has been recognized by law as an occupational sector and is therefore regulated with the aim to reduce the hyperbaric risk. Currently, French scientific diving encompasses many fields such as life sciences and ecology, geosciences, social & cultural sciences including archeology, health & food, engineering sciences, energy... Due to the existence of overseas territories - with France's maritime spaces representing the world's second largest exclusive economic zone - French territories display an extensive variety of submarine habitats. Furthermore, the historical richness of

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\*Speaker

scientific diving in France has led the French scientific diving community to be involved in all oceans worldwide. All subaquatic ecosystems, from the polar regions to the tropical belt, from drowned karsts to freshwater and high altitude lakes, including mesocosms and artificial structures are studied by diving scientists. On top of the traditional diving methods (apnea, open circuit and hookah) scientific diving benefits in recent years from the use of closed-circuit rebreathers but also from combining CCR and saturation methods, which greatly enhanced the study of the mesophotic zones. In light of the diversity of environments, disciplines and scientific issues, scientific divers are continuously innovating to perform outstanding research. This presentation will outline the recent work of the last decade highlighting the importance of scientific diving in science (in France).



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# The scientific diving network at INRAE (France)

Stéphan Jacquet<sup>\*1</sup>, Abdelkader Azougui , Simon Bazin , Vincent Bertrin , Martin Daufresne , Julien Dublon , Anne Ganteaume , Laura Garnero , Aurélien Jamoneau , Jérôme Le Coz , Mario Lepage<sup>\*</sup> , Patrice Noury , Erwan Quemere , and Samuel Westrelin

<sup>1</sup>CARRETEL, Thonon-Les-Bains – Institut national de recherche pour l’agriculture, l’alimentation et l’environnement (INRAE) – France

## Abstract

Scientific diving is now recognized as an essential tool within research institutes and INRAE (created in 2020, by the fusion between INRA and Irstea) has seized it through the establishment of a dedicated network, supported in particular by the AQUA department. With nearly thirty divers with specialties ranging from hydrodynamics to sedimentary transport, the study of biodiversity (microorganisms, invertebrates, fish) or ecological monitoring, the scientific diving network of INRAE (SDNI) is gradually being set up. The INRAE divers mainly operate in freshwater environments (lakes, rivers, estuaries...) in scuba (air, nitrox or trimix) and apnea (free diving). The underwater activities include measurements, observations (fish counts, research of alien species, photography, etc.), instrumentation (acoustic monitoring of animals such as fish, water/sediment samplers, etc.), and maintenance. The SDNI aims to promote the integration of diving as a tool among the scientific methods used within the institute. It aims at exchanging information on the different uses of diving and informs about ongoing projects involving certified divers. The SDNI is also useful for the sharing of feedback on methods, best practices and equipment. It helps to keep knowledge of current regulations up to date and to identify the types of intervention possible according to the regulations. Finally, one of the advantages of the SDNI is to identify certified scientific divers in order to create synergies between the teams. The SDNI website also provides the right addresses for training and retraining the professional Certificat of competence, as well as for following the activities of the National Scientific Diving Committee (CNPS), etc. The presentation of the SDNI and the communication around its existence can be a source of ideas for the emergence of broader collaborative work on aquatic ecosystems.

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<sup>\*</sup>Speaker

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# Use of scuba-diving for monitoring water oxygenation and charophyte distribution in shallow-lakes of the French Atlantic coast

Aurélien Jamoneau<sup>\*1</sup>, Gwilherm Jan , Cristina Ribaudó , Mario Lepage , and Vincent Bertrin

<sup>1</sup>Ecosystèmes aquatiques et changements globaux (UR EABX) – Institut National de Recherche pour l’Agriculture, l’Alimentation et l’Environnement – 50 avenue de Verdun - Gazinet, F-33612 Cestas, France

## Abstract

The littoral lakes of the Atlantic coast constitute the largest freshwater shallow-lakes system in France. They are unique natural habitats in Europe, harboring a specific biodiversity, but they are strongly threatened by global changes, notably climate change and alien species invasion. We propose to use scientific scuba-diving as a tool for monitoring 4 of these lakes and better understanding their biogeochemical functioning and biodiversity. More specifically, we foresee to position underwater automatic probes in order to monitor temperature and oxygen variations on the long term, within densely-vegetated and vegetation-free areas. The use of scientific scuba-diving will help to accurately place the probes (particularly within invasive plant beds) and to perform the maintenance. We also want to use scuba-diving to gain knowledge about the distribution of charophytes living in these lakes. This aquatic vegetation is represented by scattered individuals that are difficult to observe beyond 1m depth and to sample through common methods (typically by grab or rake). Thus, scuba-diving may be of great help in checking for the presence of these species, determining their maximum growing depth, and collecting individuals for chemical-content analyses. To this end, we propose to use regular-spaced transects perpendicular to the shoreline. We believe that scuba-diving will be a fantastic resource for better understanding the functioning and biodiversity of these lakes and thus providing valuable information for their management and conservation.

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<sup>\*</sup>Speaker

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# A novel ecosystem-based ecological evaluation index of shallow rocky reefs, tested in the NE Mediterranean.

Eleni Kytinou<sup>\*1,2</sup>, Yiannis Issaris<sup>\*2</sup>, Maria Sini<sup>1</sup>, Maria Salomidi<sup>2</sup>, and Stelios Katsanevakis<sup>1</sup>

<sup>1</sup>University of the Aegean, Department of Marine Sciences, Lofos Panepistimiou, 81100 Mytilene, Greece – Greece

<sup>2</sup>Hellenic Centre for Marine Research, Institute of Oceanography, Anavyssos 19013, Attica, Greece – Greece

## Abstract

Understanding the structure and function of shallow rocky reefs under the influence of natural and anthropic stressors is essential for evaluating their ecological status. Herein, the ECOfast index, a new integrative ecological evaluation index is developed and tested in 28 shallow rocky reef sites of the Aegean and Ionian Seas. Non-destructive SCUBA diving surveys are employed to assess all macroscopic food web components (macroalgae, invertebrates, and fish). The index is based on the assessment of selected functional groups and species, covering a wide trophic level range (1.00 – 4.53) of coastal food webs. The ECOfast and ECOfast-NIS versions of the index were developed to accommodate two distinct approaches, either accounting for or not the differential impact of non-indigenous species. In our case study, generalized additive models (GAMs) were used to assess the correlation of both versions of the index with explanatory variables. The ecological status was assessed as *moderate to bad* for 93% (ECOfast) or 96% (ECOfast-NIS) of the sites, highlighting the degraded state of shallow rocky reefs in the study area. Sites assigned to *poor* or *bad* ecological status showed dominance of ephemeral macroalgae, very low presence of large indigenous carnivorous fish, and total absence of several invertebrate functional trophic groups. Statistical differences were found in the community composition between the 5-m and 15-m depth zones for macroalgae, herbivorous species, and carnivorous fishes. Results from the best GAMs revealed negative correlations of the ECOfast and ECOfast NIS scores with sea surface temperature, and positive correlations with occurrence of carnivorous fish, while ECOfast NIS was also negatively correlated with non-indigenous fish. Sea surface temperature and carnivorous fish were proved to be the most important variables affecting the ecological status of shallow rocky reefs. The ECOfast index follows an integrative approach, has fast data acquisition and analysis protocols, and accounts for highly mobile predators and non-indigenous species that are usually not addressed by other indices. It is an efficient and easy to use tool that can be applied for the ecological status assessment of shallow rocky reefs to serve implementation of European policies (e.g., Marine Strategy Framework Directive 2008/56/EC). Acknowledgments: This research was funded in the context of the project "Development of innovative methods for the study of marine food webs" (MIS 5004302) under the call for proposals "Supporting researchers with an emphasis on new researchers" (EDULLL 34). The

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# Degraded East Aegean shallow rocky reefs: an ecological status assessment using the ecosystem-based reef-EBQI index

Eleni Kytinou\*<sup>1</sup>, Polytimi-Ioli Lardi<sup>1</sup>, Yiannis Issaris<sup>1</sup>, Vasilis Gerakaris<sup>1</sup>, George Oikonomidis<sup>1</sup>, and Maria Salomidi\*<sup>1</sup>

<sup>1</sup>Hellenic Centre for Marine Research, Institute of Oceanography, Anavyssos 19013, Attica, Greece – Greece

## Abstract

The rapid degradation of Mediterranean rocky reefs poses the need for decisive management actions and the application of integrated ecological status assessments are important for tracking changes in the functioning of these ecosystems. The ecosystem-based index reef-EBQI (Thibaut et al. 2017) was employed to assess the ecological status of six shallow rocky reef sites in the southeastern Aegean Sea (Greece). Macroalgal communities, fish assemblages and benthic macroinvertebrates were assessed along 50 m-length transects in each depth zone of 5 m and 10 m. Non-destructive visual surveys were applied, with stereo video used to assess fish abundance and length, photo-quadrats to estimate the percentage cover of macroalgal morphological groups and visual counts within strip transects to assess benthic invertebrates' abundance. Ephemeral turf-forming species dominated the macroalgal communities, followed by encrusting algae, while well-developed habitat-forming perennial and shrubby macroalgae only exhibited scarce presence. Fish biomass mainly consisted of herbivorous species, followed by omnivores and invertivores, while few piscivorous individuals were generally detected. Invertebrate communities were dominated by filter- and suspension-feeders, followed by herbivorous sea urchins, with low densities of detritus feeders and total absence of invertivorous invertebrates across the entire study area. Non-indigenous (NIS) macroalgae showed low cover, while NIS fish and invertebrates were commonly abundant in the study area. According to the reef-EBQI index, three stations were classified in *bad*, one station in *poor* and two stations in *moderate* ecological status. These findings testify to a) an ongoing collapse of perennial and shrubby macroalgal communities in favor of low ephemeral turf, b) the functional elimination of top predators (fish and invertebrate species), and c) the persistence of filter- and suspension-feeder invertebrates in shallow rocky reefs, under the combined effect of climate change and key species' overfishing. Interestingly, healthy perennial macroalgal forests were detected at certain sites; possible reasons for this resilience are herein discussed.

References: Thibaut et al. (2017). An ecosystem-based approach to assess the status of Mediterranean algae-dominated shallow rocky reefs. *Marine Pollution Bulletin* 117, 311-329

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# Exploring vulnerable canopy algae distribution in the Greek Seas (NE Mediterranean)

Polytimi-Ioli Lardi\*<sup>1</sup>, Yiannis Issaris<sup>1</sup>, Vasilis Gerakaris<sup>1</sup>, and Maria Salomidi\*<sup>1</sup>

<sup>1</sup>Hellenic Centre for Marine Research, Institute of Oceanography, Anavyssos 19013, Attica, Greece – Greece

## Abstract

The systematic decline of canopy-forming algae (*Cystoseira sensu lato* and *Sargassum* spp.) leads to significant degradation in the composition, structure and function of the rocky reef communities of the Mediterranean. The loss of canopy algae has been assigned to a multitude of pressures, such as nutrient pollution, rising temperatures, acidification, as well as overgrazing by native or alien herbivores. Untangling these mechanisms (anthropogenic and environmental stressors) and the synergistic way in which they affect macroalgal communities is a complex endeavor, especially in areas where historical data are scarce, as is largely the case of the Eastern Mediterranean basin. Moreover, the vertical distribution of these habitat-forming species at large scales has never been systematically studied thus far, further obscuring our understanding of possible causes and patterns of loss. On that account, identifying persistent canopy algae populations and exploring their distribution, structure, trends, and acting stressors along large-scale environmental gradients is a crucial first step in informing much-needed conservation and restoration efforts. Until now, six (6) sites have been surveyed by scientific scuba divers applying an ad-hoc field protocol to record canopy algae distribution along: a) vertical (from the surface down to 18 m depth) and b) parallel (at depths 0.5 m – 5 m – 10 m) transects to the shore. Stratified randomly placed quadrats (30 x 20 cm) are photographed and macroalgal cover is determined using image analysis software. Where present, fertile structures are also recorded to gain knowledge on the reproductive period of canopy algae. Presence and relative abundance of associated herbivorous species (fish and invertebrates) are recorded as well, building a concrete biotic dataset against which to investigate possible correlations with various pertinent abiotic factors (e.g., seawater temperature, salinity, pH, and nutrient concentration). In a rapidly changing marine ecosystem, information on persistent canopy algae populations will help set a scientifically-sound basis for establishing reference conditions, monitoring fluctuations over time, and applying proper management schemes that will allow the conservation of these valuable habitats.

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\*Speaker

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# Goby (Gobiiformes) diversity around Banggai Island, Central Sulawesi, Indonesia revealed by environmental DNA (eDNA) metabarcoding

Abigail Moore<sup>\*1,2</sup>, Asmi Citra Malina Tassaka<sup>1</sup>, Inayah Yasir<sup>1</sup>, Samliok Ndobe<sup>3</sup>, Widyastuti Umar<sup>1</sup>, Nadiarti Nurdin Kadir<sup>1</sup>, Amanda Pricella Putri<sup>1</sup>, and Jamaluddin Jompa<sup>1,2</sup>

<sup>1</sup>Hasanuddin University – Indonesia

<sup>2</sup>Association of Diving Schools (ADS-Indonesia) – Indonesia

<sup>3</sup>Tadulako University – Indonesia

## Abstract

Environmental DNA (eDNA) metabarcoding is increasingly used to support sustainable resource management. In the marine realm, eDNA metabarcoding often complements or involves scientific diving. Established in 2018, the Banggai Marine Protected Area (MPA) in Central Sulawesi, Indonesia is not yet fully implemented and lacks comprehensive biodiversity data. This study focussed on gobies (Gobiiformes), as part of an environmental DNA (eDNA) metabarcoding pilot project on fish biodiversity around Banggai Island. Seawater samples were collected at four sites (three replicates/site) in October 2018. PCR (MiFish 12S Teleost primers), sequence library preparation (Barber Lab, University of California Los Angeles), and high-throughput sequencing (Nextseq) generated data aggregated into amplicon sequence variants (ASVs) with taxonomic assignment using the Anacapa toolkit. At the 90% confidence level the 244 Gobiiformes ASVs over 100 bp were assigned to 30 species from 23 genera and two families (28 Gobiidae and 2 Eleotridae). In comparison, an underwater survey in 1998 recorded 19 species from nine genera in Gobiidae, also from four sites around Banggai island, including species not detected by eDNA metabarcoding. These results reinforce the need for effective fine-scale management of the fledgling Banggai MPA to conserve the still poorly known biodiversity. The high percentage of goby ASVs not assigned to species at 90% (59%) or 60% (30%) confidence levels highlights a need for specimen collection and barcoding in this region.

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\*Speaker



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# Scientific Diving in Wallacea – Perspectives from Hasanuddin University, South Sulawesi, Indonesia

Abigail Moore\*<sup>1,2</sup>, Jamaluddin Jompa<sup>1,2</sup>, and Rohani Ambo-Rappe<sup>1</sup>

<sup>1</sup>Hasanuddin University – Indonesia

<sup>2</sup>Association of Diving Schools (ADS-Indonesia) – Indonesia

## Abstract

Wallacea, within the Coral Triangle, is widely recognised as a biodiversity hotspot, and as a region where many scientific questions remain to be answered. With respect to many disciplines, seeking the answers is likely to involve scientific diving, in particular regarding biodiversity, evolution, biogeography and ecology, as well as geology, maritime history, bioprospecting and pharmaceutical research, climate change, and others. Hasanuddin University (Unhas) in Makassar, South Sulawesi Province, is the only university in eastern Indonesia with the prestigious PTBN (higher education legal entity) status. The Faculty of Marine Science and Fisheries has been one of the flagship units within the university; to date, scientific diving at Unhas has mostly focused on marine science and fisheries research, supported by our Marine Station on Barrang Lompo Island in the Spermonde Archipelago, Makassar Strait. The current Rector of Unhas is a scientific diver who is also the Head of the Indonesian branch of the Association of Diving Schools (ADS-Indonesia), which has a special section for scientific diving instructors and promotes student certification. Unhas is increasing its focus on interdisciplinary science and partnerships, including programs involving scientific diving. So far, these range from classic underwater visual surveys to eDNA metabarcoding, and from exploring mesophotic ecosystems to tracing geological and climate history and processes. Partnerships are vital to access and maximise the use of resources to improve our collective knowledge and support sustainable management of our biosphere, especially this exceptional area. This poster will provide an overview of some recent programs, Unhas facilities, and the potential for international collaboration.

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# Ichthyofauna associated to decommissioned artificial reefs – the case of oil rigs in northern Peru

Bernabé Moreno\*<sup>1,2</sup> and Diego Cuba<sup>2</sup>

<sup>1</sup>Marine Ecology Department, Institute of Oceanology Polish Academy of Sciences – Poland

<sup>2</sup>Carrera de Biología Marina, Universidad Científica del Sur – Peru

## Abstract

Over twelve thousand oil-and-gas platforms sit on the seabed worldwide. These artificial reefs provide a structurally complex habitat facilitating secondary production both on the structures and their surroundings, ultimately enhancing biodiversity and biomass. While legislative instruments such as the OSPAR Convention prohibit leaving the jacket-structure on site once extraction period ends, other jurisdictional schemes are more flexible, allowing repurposing of the structures (rigs-to-reefs) which has proven beneficial for the environment through the provision of abovementioned ecosystem services. Peruvian seas are biodiverse, host a considerable large biomass of bioresources, are rich in hydrocarbon reservoirs, and its legislation falls in the latter category. Three oil rigs were surveyed covering a 10 latitudinal range along Peruvian north shore in the Tropical Eastern Pacific marine province. Metazoan assemblages associated to and surrounding the structures were studied focusing on fish abundance and diversity. Fish aggregations were registered and counted by scientific divers and using high-resolution action cameras including a time-lapse system placed at 15 m in one of the structures. Five depth strata were considered following 5m- (first two) and subsequently 10m-intervals down to 40 m depth at the southernmost oil rig studied; "MX-1". A total of 31 separate person-dives and ~1,200 minutes underwater were logged in 14 diving instances of which three were planned decompression dives. Dives were conducted during austral winter (2021) and spring (2021 and 2022) comprising a wide temperature range of 15–24°C at max depths. Fish assemblage composition varied between the oil rigs and were significantly different according to depth. The higher species richness (S=28) was recorded associated to "MX-1" where fish abundance was also one order of magnitude greater. Rare and new distribution records include one individual of the Cortez sea-chub *Kyphosus elegans* at the shallowest depth strata of "Delfín Sur-1X" oilrig, and one Peruvian morwong *Cheilodactylus variegatus* observed several times throughout the study at 5m in "MX-1". A higher number of species is hypothesized, therefore, to maximise the taxonomic list we suggest i) conducting surveys spanning different seasons throughout several years to cover different ENSO phases, ii) looking exhaustively for cryptic ichthyofauna in small crevasses, iii) expanding the depth limit using different gas mixtures, vi) reducing the divers' disturbance using e.g., more time-lapse cameras, ROVs, or implementing the use of closed-circuit rebreathers. Reportedly, this is the first time that decompression dives have been conducted for scientific purposes in Peruvian waters. With such studies we provide baseline information supporting the benefits of permanently 'reefing' the platforms as an attractive proposition providing subsequent benefits for stakeholders. This contributes to the knowledge of peculiar man-made habitats that are found within the proposed Marine Protected Area "Mar Pacifico Tropical."

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\*Speaker

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# Testing diving-based restoration methods for eelgrass (*Zostera marina*) in the Baltic Sea

Liina Pajusalu\*<sup>1</sup>, Kaire Kaljurand<sup>1</sup>, Tiia Möller-Raid<sup>1</sup>, and Georg Martin<sup>1</sup>

<sup>1</sup>Estonian Marine Institute, University of Tartu – Estonia

## Abstract

Seagrass meadows are important components of soft-bottom coastal ecosystems worldwide, providing habitat and shelter for numerous marine species and thereby are known as essential hotspots of biodiversity. Seagrass meadows are globally in serious decline, losing both area and biodiversity. Habitat restoration could reverse this degradation, but so far, the success rate of seagrass restoration has been low. The main aim of this study was to develop new restoration techniques and approaches for eelgrass *Zostera marina* in a brackish water environment where the eelgrass reproduces only vegetatively. We tested transplanting eelgrass with ropes and meshes in different sites (sheltered and exposed) in the north-eastern Baltic Sea. Divers using SCUBA buried the ropes and meshes containing the attached eelgrass shoots under the sediment. Furthermore, during eelgrass restoration activities diving-based monitoring and sampling were conducted. The shoot density of planted eelgrass increased over time, especially in the sheltered site, indicating that restoration is possible in these areas. It should be highlighted that the success rate of habitat restoration also depends on diving techniques as well as divers' abilities.

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\*Speaker

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# Shipwrecks: Carbon Communities

Rachael Priest\*<sup>1</sup>, Clare Fitzsimmons , and Pippa Moore

<sup>1</sup>School of Natural and Environmental Sciences, Newcastle University – United Kingdom

## Abstract

Deep oceans, seagrass beds, mudflats, and mangroves are examples of marine ecosystems that provide us with essential services. These services include carbon capture, coastal protection, and food provision, but with the growing human population, increasing demands are being placed on the marine environment and the services that it provides. As such, it is important that we are able to quantify and assess marine services to ensure sustainable management. One marine service that is often overlooked, is offered by shipwrecks. Over 37,000 of shipwrecks litter the English coast, providing sanctuary to marine species. This has implications for biodiversity and carbon storage on shipwreck sites, but it is unclear to what extent shipwrecks impact the distribution of benthic carbon stores. In this work, we investigate the potential distribution of benthic carbon stores across several shipwrecks, from the Tyne to Tees, England. Whilst shipwrecks are known to be biodiversity hotspots, there is a need for more in-depth understanding of the benthic seafloor surrounding them. This research broadens the services that shipwrecks offer and highlights the need to include them as carbon providing ecosystem services.

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\*Speaker

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# The evaluation of ecosystem in Zakrzówek quarry in Poland

Kłosiński Radosław\*<sup>1</sup>, Piotr Dynowski<sup>2</sup>, Thomas Grab<sup>3</sup>, and Kinga Korniejenko<sup>4</sup>

<sup>1</sup>AKP "Krab" AGH, Władysława Reymonta 21A, 30-059 Cracow, Poland – Poland

<sup>2</sup>Faculty of Geoengineering, University of Warmia and Mazury in Olsztyn, Prawocheńskiego 15, 10-720 Olsztyn, Poland – Poland

<sup>3</sup>Scientific Diving Center, TU Bergakademie Freiberg, Gustav-Zeuner-Straße 7, 09599 Freiberg, Germany – Germany

<sup>4</sup>Faculty of Materials Engineering and Physics, Cracow University of Technology, Jana Pawła II 37, 31-864 Cracow, Poland – Poland

## Abstract

### The evaluation of ecosystem in Zakrzówek quarry in Poland

Kłosiński R1\*, Dynowski P2, Grab T3, Korniejenko K4

*1 AKP "Krab" AGH, Władysława Reymonta 21A, 30-059 Cracow, Poland*

*2 Faculty of Geoengineering, University of Warmia and Mazury in Olsztyn, Prawocheńskiego 15, 10-720 Olsztyn, Poland*

*3 Scientific Diving Center, TU Bergakademie Freiberg, Gustav-Zeuner-Straße 7, 09599 Freiberg, Germany*

*4 Faculty of Materials Engineering and Physics, Cracow University of Technology, Jana Pawła II 37, 31-864 Cracow, Poland*

\* e-mail: [radek.21@wp.pl](mailto:radek.21@wp.pl)

The article presents the first part of the research carried out under joint research project between the Republic of Poland and the Federal Republic of Germany under the grant 'Underwater Eco-monitoring'. The main objective of the project is to prepare a scientific method for monitoring inland water reservoirs, with regard to fauna and flora, taking into account human activity. Investigation in the first phase is focused on understanding and characterizing the Zakrzówek quarry and reported the stage before construction works based on available databases, research materials, literature, and other sources, including archives of the AKP "Krab" AGH (diving club from Cracow). It is worth to mention that since the beginning of the 20th century, limestone has been extracted in the quarry in Zakrzówek

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\*Speaker

(Cracow, Poland). Once mining was stopped in 1991, the excavation was filled with water, and an area became popular diving spot. Parallel to diving activity, in this water reservoir, there was a process of introduction of flora and fauna. The natural ecosystem starts to work there. In the summer of 2019, Zakrzówek has been officially closed until 2021, during which time the city has plans to develop it into a recreation area. Due to the problems with COVID-19, the maintenance works are continuing in 2022 and the official opening of the water reservoir will be in 2023. The results obtained from the query provided describing the flora and fauna, as well as underwater landscapes in the quarry before the construction works. The next step will be create reports after construction works, including the influence on underwater life the construction materials.

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## Contribution of bottom sampling for improved detection of marine fishes in costal areas through metabarcoding

Roblet S<sup>1\*</sup>, Priouzeau F<sup>1</sup>, Gambini G<sup>1</sup>, Sabourault C<sup>1</sup>, Derijard B<sup>1</sup>

<sup>1</sup> UMR 7035 ECOSEAS (CNRS-Université Côte d'Azur), 28 Avenue de Valrose, 06000 Nice, France

\* e-mail: [sylvain.roblet@univ-cotedazur.fr](mailto:sylvain.roblet@univ-cotedazur.fr)

### Abstract

Coastal biodiversity monitoring is critical to assess the effects of climate change and human pressure on marine ecosystems. Environmental DNA (eDNA) metabarcoding appears as a new promising tool to achieve this goal in particular for fish communities, as it complements traditional survey methods, such as underwater visual census, and allows the detection of more species. However, in most of the studies using metabarcoding to survey coastal fishes, sampling has only been performed in surface waters. More work is needed to assess if this sampling effort is enough to have a good picture of fish community composition or if bottom samples should also be added. Here, we conducted an eDNA study in the Marine Protected Area (MPA) of Cap Roux (Mediterranean Sea, France) to characterize fish diversity. We sampled at the same time and along the same transect (~1,3km), 30L of surface water (one meter below the surface) using a pump linked to a boat (n=4) and 30L of bottom water (one meter above the substrate, maximum depth: 30m) with a pump fixed on an underwater scooter carried by divers (n=4). The transect was designed to cross several habitats to detect as many species as possible. In terms of alpha diversity, we found that differences in species richness between bottom and surface samples were not significant. However, for beta diversity, differences in species composition were highly significant. Five fish families including highly mobile pelagic fishes and species doing nychthemeral migrations were only detected in surface samples whereas six were uniquely detected in bottom samples, in particular cryptobenthic and ray species. We therefore recommend combining both sampling strategies in order to have a more complete vision of fish communities, an essential objective for MPAs management.

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\* Speaker

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# Using scientific divers to undertake sentinel monitoring of English marine protected areas

Trudy Russell\*<sup>1</sup>

<sup>1</sup>Natural England – United Kingdom

## Abstract

Natural England is a UK government agency with responsibility for monitoring the condition of marine protected areas (MPAs) in English in-shore waters. In recent years the number of designated MPAs has almost tripled without any sustained increase in funding for monitoring. To manage this we have developed a monitoring prioritisation system using sentinel sites. The sentinel sites have repeated monitoring to understand trends in condition with enough confidence to allow inference to no-survey sites. Natural England's Dive Unit was tasked with designing and undertaking sentinel monitoring of subtidal reef communities in one southern and one northern sentinel site. Sites were prioritised with an assessment of habitat vulnerability, monitoring importance and quality/quantity of historic data. From the long list two high scoring sites that were suitable for diver monitoring were identified – Plymouth Sound and Estuaries Special Area of Conservation (SAC) and Berwickshire and North Northumberland Coast SAC. Both sites are designated for Annex 1 reef. The survey programme was designed primarily to monitor the condition assessment attribute:

- Structure: Species composition of component communities (with the target: Maintain the species composition of component communities).

It also provides data to support the assessment of the following attributes:

- Structure: non-native species and pathogens (with the target: Reduce the introduction and spread of non-native species and pathogens, and their impacts).

- Distribution: presence and spatial distribution of biological communities (with the target: Maintain the presence and spatial distribution of reef communities). The site at Plymouth has been surveyed in 2017, 2018, 2019 and 2021 and has comparable historic data back to 1998. The first survey at Berwick was in 2019 with the delayed follow up planned for July 22. In the talk I will present the survey methods used, key findings and share lessons learnt from the development of this project.

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\*Speaker



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# How noisy is the largest naturel deep lake in France?

Théophile Turco<sup>\*1</sup>, Marylin Beauchaud<sup>2</sup>, Stéphan Jacquet<sup>\*3</sup>, Jonathan Grimond<sup>4</sup>, and Vincent Medoc<sup>2</sup>

<sup>1</sup>Université Jean Monnet – Saint-Etienne, Université de Lyon, CNRS, INSERM, CRNL/ENES, Saint-Etienne – Centre National de la Recherche Scientifique - CNRS, Université Jean Monnet de Saint-Etienne – France

<sup>2</sup>Université Jean Monnet – Saint-Etienne, Université de Lyon, CNRS, INSERM, CRNL/ENES, Saint-Etienne – Centre National de la Recherche Scientifique - CNRS, Université Jean Monnet - Saint-Etienne – France

<sup>3</sup>CARRETEL – Institut national de recherche pour l’agriculture, l’alimentation et l’environnement (INRAE) – France

<sup>4</sup>SUBBEAR – Bureau d’Etude en Environnement – France

## Abstract

Anthropogenic (man-made) noise is one of the less visible but widespread symptoms of human activities around the world. Its ecological impact on fresh waters remains under investigated. French peri-alpine lakes are key resources for the territories. With the development of tourism and transport, noise emissions from human activities are at the heart of social, economic and environmental issues. The POLLUSON project aims at quantifying noise pollution and its impacts on wildlife in Lake Bourget, the French largest natural lake. We used scientific diving to set up underwater acoustic recorders at five strategic locations that differ in terms of noise exposure. Diving allowed us to deploy the recorders on appropriate substrates, to check their functioning and to collect the data every four months. We assessed the phenology of noise pollution, calculated the increase in sound level and used unsupervised automatic approaches to characterize the diversity of artificial sounds.

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\*Speaker

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## 3D printed artificial reef deployment in the Atlantic coast: project overview and results

Pieter van der Linden<sup>1,2\*</sup>, Bianca Reis<sup>1,2</sup>, João N. Franco<sup>1,2,3</sup>, Maria Teresa Borges<sup>1</sup>,  
Isabel Sousa Pinto<sup>1,2</sup>

<sup>1</sup> Faculty of Sciences, University of Porto, Portugal

<sup>2</sup> Interdisciplinary Centre of Marine and Environmental Research (CIIMAR), Matosinhos, Portugal

<sup>3</sup> MARE-Marine and Environmental Sciences Centre & ARNET—Aquatic Research Network  
Associated Laboratory, ESTM, Polytechnic of Leiria, 2520-641 Peniche, Portugal

\* e-mail: [lindenvdpieter@gmail.com](mailto:lindenvdpieter@gmail.com)

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### Abstract

Artificial reefs (AR) have been deployed around the world for many purposes including habitat restoration, coastal protection, fisheries enhancement and recreation. Currently there is a global drive to create “grey-green” infrastructure, where multifunctional artificial structures are designed to perform their primary safety function as well as provide ecologically suitable habitat for marine life. 3D printing creates an additional opportunity to design complex reef units, incorporating features similar to those found on natural temperate reefs.

The Interreg Atlantic 3DPARE project has designed and 3D printed concrete artificial reef units to maximise marine biodiversity. These units include various habitat features including holes, tunnels and overhangs of varying size. The AR units were deployed during Spring/Summer 2020 in the UK, France, Spain and Portugal nearshore. Seasonal biological monitoring has focused on the influence that the material type, reef design and specific AR unit features have on biodiversity and was also compared to nearby artificial and natural habitats.

Results have found that reef material, design and feature type all contributed to variation in marine-life communities over different seasons, but feature type was the most influential. Diversity was highest in large holes and tunnels of the AR modules. The 3D AR sites also support unique communities compared to the nearby artificial and natural reference sites. This research shows that 3D printing is a viable option to create reef units for use in future hybrid multifunctional structures, which include features such as holes and tunnels that can support a variety of marine life.

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\*Speaker

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